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A Developmental Study of Concept Formation Behavior in Pre-school Children as Measured by the Hunter-Pascal Concept Formation Test

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To the Graduate Council:

I am submitting herewith a dissertation written by Bernard D. Kaiman entitled "A Developmental Study of Concept Formation Behavior in Pre-school Children as Measured by the Hunter-Pascal Concept Formation Test." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Psychology.

Gerald R. Pascal, Major Professor

We have read this dissertation and recommend its acceptance:

William O. Jenkins, Carl N. Sipprelle, Merritt H. Moore, William E. Cole

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

August 4, 1958

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Major Professor

We have read this thesis and recommend its acceptance:

Accepted for the Council:

Dean of the Graduate School

A DEVELOPMENTAL STUDY OF CONCEPT FORMATION BEHAVIOR IN PRE-SCHOOL CHILDREN AS MEASURED BY THE HUNTER-PASCAL CONCEPT FORMATION TEST

A THESIS

Submitted to
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of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Doctor of Philosophy

by

Bernard D. Kaiman

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Bernard D. Kaiman

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CHAPTER I

INTRODUCTION

In psychology the investigation of the formation of concepts has long been a part of the study of what has been called the thought processes. There are, however, very few studies of early concept formation in humans, especially in children before and during the development of speech patterns. Most of the studies which have dealt with the investigation of concept formation have depended largely for their data on speech processes. It can, however, be shown that concept formation exists before speech behavior, and that its development seems to be somewhat parallel to the development of speech in the child. The literature on this problem indicates a considerable hiatus in this area of investigation of concept formation in the very earliest years of the human organism.

In the present research the approach chosen was that of the investigation of the problem of the earliest appearance of a fairly limited form of concept formation behavior in the human organism, and of tracing its development as the organism matures, thus making some sort of a beginning

in showing how the internal processes which we infer from the overt and observable behavior of the organism follow their maturational patterns.

To clarify a term, the present study is concerned with a group of behaviors, observable and quantifiable, from which "concept formation" as some sort of internal, possibly central, symbolic process can be inferred. Such behavior will be called here "concept formation behavior" or "concept behavior". An answer to the question of what the internal processes might be, will not be attempted here.

Statement of the Problem

Basic Postulate. The basic assumption of the present study can be expressed fairly concisely. The development of concept behavior in young children is orderly and progressive largely along maturational lines, being relatively free of influences such as might be expected from differences among individuals in environment, intellectual ability, sex, and so forth. In other words, the concept behavior of a group of children is homogeneous across maturational levels, in spite of a good deal of heterogeneity in the subjects as regards environmental or personal factors.

Following from this assumption, then, the basic variables which we might want to identify in the present study at this time can be labeled thus: the independent variable is the level of maturation of the individual, or groups of individuals under study, and the dependent variable is the concept behavior as measured by the experimental procedure.

Predictions. On the basis of this postulate several predictions which might be made of the experimental findings seem immediately apparent. The first prediction which can be made is that there will probably be a relatively high positive correlation between chronological age and measures of successful concept behavior (R_1). The second prediction which comes to mind is that there will probably be a relatively low but possibly positive correlation between measures of successful concept behavior and measures of socio-economic status (R_2). A third prediction is that there will probably be a relatively low but possibly positive correlation between measures of successful concept behavior and measures of intellectual abilities (R_3). A fourth prediction is that there will probably be a relatively low but possibly positive correlation, between measures of success-

ful concept behavior and measures of other variables (R_n). A fifth prediction that can be made is that there will probably be significant differences between R_1 and R_2, between R_1 and R_3, and between R_1 and R_n. Finally a sixth prediction that can be made is that there will probably be no significant differences between R_2, R_3 and R_n. In other words, the problem presented here will investigate the assumption that the larger portion of the variation in concept behavior in a group of young children will be the variation presented by the maturation variable as contrasted with the variation presented by other variables which are available for measurement.

Secondary Problem. In the light of the basic assumption and above predictions, an auxiliary problem that presents itself is that it seems possible to lay the basis for the development of a scale of performance for young children which might be used, in a sense, as a kind of test of normal maturation. Insofar as the maturational factor can be shown to account for the larger portion of the variation between children in a particular type of behavior labeled "concept formation behavior", it appears therefore that measuring this behavior might provide a more or less reliable measure

of development of at least this aspect of maturation in young children. The primary problem, however, of the study is concerned with the growth and development of concept behavior in young children, particularly as revealed by the Hunter-Pascal Concept Formation Test.

Organization of the Study. The Hunter-Pascal Concept Formation Test (hereafter abbreviated, H-P Test) is a graded series of problems involving both delayed reaction and alternation problems. The delayed reaction problem can be described as basically a situation in which the organism, in this case a child, is confronted with the problem of remembering which of several different possible responses is the correct one and will result in obtaining the reward object, in this case a bit of candy. The cue for correct response has been given, but is no longer present. Having seen the candy placed behind one of five doors, can the child remember which door conceals the candy? If he remembers, can he remember over varying spans of time?

The alternation problem requires the organism to make a sequence of different responses to obtain the reward objects with no differential stimuli present to act as cues to the correct responses. The child must learn the correct

response in the sequence, retain it, and utilize it to make the next correct response in the sequence. Can the child learn, with no cues given him, that the candy he seeks is one time concealed behind the left-most of five doors, and the next time behind the right-most door?

Based on considerable experimentation with the H-P Test (31) a series of problems has been developed using three delayed reaction problems, a transitional problem involving both delay and alternation, a single alternation problem, a double alternation problem, and three problems involving combinations of single and double alternation. The present study makes use of just the first five problems.

The subjects of the study are seventy children ranging in age from four months to sixty-four months, mostly from several nursery schools in the city of Knoxville, Tennessee. They were all tested with the H-P Test between December, 1957 and May, 1958.

The chronological age (CA) of all subjects is known, and can be compared with their H-P Test performance to arrive at data showing the relationship between age and test performance. For thirty of the subjects (<u>S</u>s) Stanford-Binet Intelligence Scale results have been obtained and will be

compared with the H-P Test performance of this group of Ss to provide data concerning the intelligence variable. The comparison of the performance on the H-P Test of boys with that of girls can provide data on the sex variable. The level of education and the occupations of the fathers of all Ss is known and can be compared with performance on the H-P Test of the Ss to provide data concerning the effect of these variables on test performance.

CHAPTER II

REVIEW OF THE LITERATURE

The Delayed Reaction Method

The delayed reaction technique has been an important tool in the study of symbolic processes. Indeed, as Munn puts it (30), "investigations of symbolic memory in animals and in human infants not yet possessed of verbal responses must be confined to the delayed reaction phenomenon".

The use of the delayed reaction (DR) method to study symbolic processes in animals owes its inception to Carr and was first used by Hunter (15) under Carr's direction to study recall memory in rats, dogs, raccoons, and children, in a research which is the forerunner of a large body of literature on studies in this area with animal Ss.

Hunter first taught his Ss to associate a light with food, then the light was turned off some seconds or minutes before the response could be made. For the S, the problem was to remember over the span of time, in which of three compartments the light had been. Hunter found only one

rat which could delay as much as ten seconds while raccoons could delay up to twenty-five seconds. Hunter also found that rats and dogs delayed correctly only when bodily orientation in the direction of the correct door was present, but that raccoons and children needed no such positional cues to make the correct responses. McCord (28) arranged a situation which eliminated the factor of positional cues, and found that rats could delay up to six minutes. In a study by Cowan (7), cats delayed successfully up to sixteen hours. The DR in primates has been studied by such research workers as Tinkelpaugh (41), Harlow (12) using complexities such as the Weigl principle, and Jacobsen (21) in investigation of the results of cortical ablations.

With this representative sample of the sort of animal research that has made use of the DR method, we can turn to studies directly involving children. These can be divided into three groups of studies, the biographical, the clinical, and the experimental. As an example of the biographical, Hurlock and Schwartz (20) summarized the memory data reported in thirty-six infant's biographies, citing examples of infants who exhibited responses which were judged to be attempts at locating objects which had disappeared for vary-

ing lengths of time. Criticisms of studies of this sort can be leveled on the basis of these being mixtures of fact and interpretation, and involving too much anecdotal evidence. Buhler's, et al, (4) studies can be categorized as clinical, and include DR responses. For instance, most five month old children pass her test of looking for a toy which has been removed. These studies can be criticized on the basis that careful controls are frequently lacking in the clinical situation, and that this situation may permit the S to pick up extraneous cues from the examiner to dilute the findings.

Experimental studies of children in DR situations again begin with Hunter's original study of rats, dogs, raccoons, and children (15). He used five Ss aged two and one half to eight years old. The youngest girl responded with considerable accuracy with delays of up to fifty seconds. Longer delays led to reduced accuracy. The other children, three of whom were six years old and the other eight, could delay up to five to thirty-eight minutes. In a later study (16), Hunter used his daughter, Thayer, and determined that as early as eleven months old, on a three box problem, she could search for hidden objects. At sixteen months the child could delay for fifteen seconds with about 75% accuracy, while twenty-five seconds of delay re-

sulted in about 50% accuracy.

Allen (1) used as Ss fifty-two boys and forty-eight girls all of about one year old. He found no significant sex differences using delays of ten seconds in which the accuracy was about 64%, twenty seconds in which the accuracy was about 60% and thirty seconds in which the accuracy was about 50%.

Miller (29) was particularly interested in the cues used by children to remember the position of test objects, especially the cues of position and cues of box characteristics. He used as Ss ninety children aged 11½ to 162 months old, and tested them all with a delay of ten seconds. His procedure involved two boxes with the response possible to either position or color of the box. He found that children under two years old all responded in terms of position relative to the other box. Between the ages of two and three the children responded about 80% of the time to position and about 20% of the time to color of the box. With older children the color of the box became increasingly important.

Skalet's (37) study is the first which offers systematic data concerning ability in DR as a function of age. Her Ss were sixty children from twenty-four to sixty-six

months old and she used two methods of experimentation. The first involved an animal cracker hidden under one of three plates. She found the children could delay from one to thirty-four days and that the correlation between the maximum correct delay and CA was .478. The second procedure involved the recognition of figures -- animals and geometric figures, using delays of from a few minutes to five days. She found that only with the simple and familiar figures was there any correct response and that the correlation between correct delay and CA was .699.

Emerson (10) using thirty-two Ss aged twenty-nine to fifty-nine months old tested the effect on recall of disturbances in bodily orientation. The child was required to reproduce a motor performance done by the examiner in nine positional situations with a five second delay occurring in each of the situations. She found that bodily disorientation during delay greatly decreased accuracy. She found also that the correlation between the average number of correct placements and CA was .77 while with mental age (MA) it was .758. She also found no significant sex differences.

Pascal and Stolurow (32) using twenty-seven mental

defectives ranging in CA from 5-11 to 31-10 and in MA from 2-1 to 7-1 made a comparison between position and object cues in DR responses. They found that the maximum place delay was correlated with the CA at .13, while the correlation with MA was .61. The correlation between the maximum form delay and CA was .38, while the correlation with MA was .88.

Collins and Tapp (6) used a series of DR situations in a preliminary study very similar to that of the present study with their group of forty-six children aged five months to sixty months, and have derived a growth function which suggests the existence of an orderly relationship between maturation and DR performance.

To summarize the findings from the DR literature on studies of children, we find that both Allen and Emerson find no sex differences in the ability to delay. Allen established what appears to be an upper limit to correct delay responses in one year olds, while Emerson showed the importance of controlling for positional cues. Miller studied the determinants of the cue to correct response and established the relative importance of position and color as stimulus characteristics. The only studies that show a re-

lationship between age or maturation, and ability to delay correctly, are those of Hunter, who had only five Ss; Skalet, whose youngest S was two; Emerson, whose youngest S was twenty-nine months; Pascal and Stolurow whose Ss were mental defectives with lower limits chronologically of 5-11 and mentally of 2-1, and Collins and Tapp, whose preliminary study suggests an orderly growth function in Ss comparable to those of the present study and in a similar DR situation.

The Alternation Method

The alternation method, commonly the Double Alternation (DA) problem, has also been an important tool in research into the symbolic processes of both animal and human Ss.

Again beginning with the work of Carr (5) and Hunter (17), a whole body of comparative studies has established a close relationship between DA performance and phylogenetic development, going up the scale from rats (19) to raccoons (17), to monkeys (11), to human children and to human adults (11). The findings show that rats do very poorly in DA performance, raccoons perform

at a much higher level, and monkeys are far superior to these lower mammals. The DA responses of human children were quite superior to those of infrahuman animals, while human adults ranked highest.

Gellerman (11) used thirty-eight children with the youngest aged three in his study comparing monkeys, children and adults, in a temporal maze situation involving DA for children. The correlation for children between trials to learn and CA was .28. All his Ss of four years old and older learned the response, but errors and trials needed to learn were much greater in children than in adults.

Hunter and Bartlett (18) in a double-box situation, used thirty-one children aged two to six years. Only two of his eight three-year-olds solved the DA problem, while all of the eleven four-year-olds succeeded. The correlation between CA and trials to learn was .86, and that between MA and trials to learn was .81.

Stolurow and Pascal (38) using twenty mental defective children, found that the minimum MA for solution of a DA problem was 5-5 and that the correlation between Binet MA and trials to learn was .83. Correlation with CA was not significant.

Hodges (14) using a five card DA situation, found a correlation of .766 between CA and DA performance in his group of two hundred and forty children six to twelve years old.

Pascal and Zax (34) used the DA procedure to test cerebral palsied children seven to twenty years old and found a correlation of .43 between MA and DA performance, and a correlation of .73 between such performance and behavioral ratings of ability to learn, and cooperativeness.

Collins and Tapp (6) reported that no child in their group of forty-six Ss five months to sixty months old, could perform the single alternation problem, a simplification of the DA task, in a situation very similar to that of the present problem.

Summarizing the findings from the literature on the use of the alternation method in the investigation of symbolic processes in children, we find that only Collins and Tapp used single alternation methods and also very young children. All the other studies cited used DA methods and children two years and older, but apparently all succeeded in showing a clearcut relationship between DA performance and CA, or at least MA.

Considering the literature of both the DR and alternation methods together, only Collins and Tapp in their preliminary study did make an attempt to relate DR to alternation performance, in order to establish a growth function.

Developmental Studies of Concept Formation

The literature is replete with numerous studies of concept formation in children using a wide variety of methods and Ss to investigate many kinds of concept formation. Since it is not our purpose to explore the meaning of the term "concept formation" a summary of the kinds of developmental work that has been done in this area may provide some understanding of the breadth of the research work that has been done in the investigation of symbolic processes in children, and especially in terms of the relationship between CA and the development of concept formation.

In the experimental literature the ability to learn the concept of "triangularity" has been demonstrated in infants at about fifteen months (25); "roundness" in children at about age three (26); "big" and "little" in children of two years old and "middlesizedness" in three year olds (13) (40); "today" in children twenty-four months old,

"tomorrow" in children thirty months old and "yesterday" in children thirty-six months old (2); and cause and effect relationships in children of about the eighth or ninth year (23). The Stanford-Binet test (39) demonstrates number concepts by including the counting of four objects at the five year level, and concepts of "attractiveness" at the four year, six month level.

The work of Piaget (35) has been important in being the bellwether of a whole group of studies based on what are largely questionnaire techniques of investigating children's concepts, which, while somewhat irrelevant for the present study, yet illustrate another method of studying the development of conceptualization. Mostly, of course, the Ss of such investigations are of verbal age. Children's thinking according to Piaget goes through a series of distinct stages of development, successive and typical of different ages. In discussing his findings in regard to many different concepts, he defined the successive stages and tied them to age. The four stages of animism, for example, are said to occur at about four to six, six to seven, eight to ten, and eleven and older.

Criticisms of Piaget's work have been numerous, the most important of which is that there is little evidence

of "stages" of development, but that conceptual thinking shows a gradual progression with advancing age (9).

Welch and Long (42) have shown how the conceptualizing ability in children seems to evolve from the simple to the more complex. At about twenty-six months children can grasp the point that "men" and "women" are all "people" -- a first hierarchy concept, and in about the middle of the fourth year grasp the ideas that "potatoes" are "vegetables", "apples" are "fruit" and both "vegetables" and "fruit" are "food" -- a second hierarchy concept.

Reichard, Schneider and Rapaport (36) found three levels of conceptual ability among children in sorting tests. A concrete sorting on the basis of nonessential incidental features of the objects was typical of children up to five or six, a functional sorting on the basis of use or value was more typical of children up to eight or ten, while a conceptual sorting on the basis of abstract properties or relations was seen after about ten years of age.

Summary of the Literature

Arising out of phylogenetic studies of the performance of animal Ss in the main, the DR method has proved to be an important tool in the investigation of symbolic processes in many different kinds of organisms, and in human children seems to offer an invaluable method of investigating conceptual processes in very young children, even those below verbal ages. From the literature we find that little work has been done in this area with very young children and that a clear-cut relationship between CA and DR abilities is as yet to be established.

The alternation method too, has had a long and honorable history as a tool in the investigation of the conceptualization process, and in the several studies found has been the medium for the yielding of an orderly growth function showing a distinct relation between the development of conceptualizing abilities and CA. These studies usually involve Ss of verbal ages. The use of both methods for the derivation of a growth function which includes both the preverbal and the earlier verbal years of maturation of the child seems to be a logical step. The literature reveals, furthermore, that little work has been done in the area of

relating alternation abilities with other abilities such as DR in order to derive such an orderly and continous growth function.

The literature of developmental studies of concept formation is voluminous, especially experimental studies in the area of demonstrating the age levels at which specific "concepts" fall into place. A study of the literature reveals, however, that a gap exists at the lowest levels of the earliest years of life and that the existence of the earliest conceptualization abilities which might evolve into these more specific and complex "concepts" has yet to be investigated systematically and developmentally. The truly developmental studies of conceptual ability have depended largely on verbal methods and thus again yield little data concerning earlier developmental trends.

Thus, while conceptualization and the development of concept formation are considered to be highly important in the study of symbolic processes, little has been done in a systematic and quantitative way to investigate the growth and development of conceptualization during the first four or five years of life. The present study is a move toward filling this gap.

CHAPTER III

PROCEDURE

Experimental Design

The H-P Test was administered to seventy children ranging in age from four months to sixty-four months. The testing took place mostly in several nursery schools in the Knoxville area. Data were obtained on the chronological age and sex of the Ss, as well as data on the father consisting of the highest grade in school he completed and his occupation. For thirty Ss Stanford-Binet Intelligence Scale results were obtained.

Using the various available measures of performance on the H-P Test, the effect of the following variables was investigated: chronological age; intelligence; sex; educational level of the father; and occupational level of the father.

Selection of the Subjects

The major criterion for the selection of Ss was chronological age. As the experimenter (E) visited the

various nursery schools from which the S population was drawn, it was with the aim of achieving as broad a range of CA as possible within the selected range of four months to sixty-four months. The number of Ss available for testing in each age level determined the choice of S.

The aim of achieving a spread of Ss across the selected age range was achieved with some fair degree of success. Table I summarizes the number of Ss in each age level. It will be noted that in each age group there are from two to six Ss, averaging 3.7 Ss per age level.

Some attention was paid to selection of Ss by sex, in order to try to achieve some measure of balance between the sexes. Of the final experimental sample, twenty-nine are females, and forty-one are males.

All but five of the children were pupils at four nursery schools in Knoxville, Tennessee. These are private institutions, located in middle-class neighborhoods, whose pupils seem to be drawn from a fairly wide range of socio-economic levels, but with the larger proportion from upper levels. Three Ss were tested in a day-care home, a category of nursery established for the care of children under two years old. Two children were seen in their homes.

No child was chosen as a S unless judged as "normal"

TABLE I

DISTRIBUTION OF Ss ACCORDING TO CHRONOLOGICAL AGE

Age in Months	Number	Age in Months	Number
4-10	2	38-40	4
11-13	4	41-43	5
14-16	5	44-46	2
17-19	5	47-49	4
20-22	3	50-52	2
23-25	4	53-55	3
26-28	4	56-58	6
29-31	2	59-61	4
32-34	3	62-64	2
35-37	6		

meaning usually exhibiting no obvious behavioral or physical deviancies, or whose behavior for the day was termed deviant. These judgments were made by their teachers (or parents in the case of the two seen at home). No child was tested within one hour after having had food. All Ss were of the white race. Appendix A presents the personal data obtained on each S and father.

The Hunter-Pascal Concept Formation Test

Apparatus. The H-P Test (31) utilizes an apparatus similar to that which has been used on prior occasion to investigate DA behavior by Pascal (33). A diagram of the apparatus is to be found in Appendix B. Basically it consists of a vertical white surface containing five identical black doors which are hinged at the top to open upward and away from the S upon light pressure of a finger. Behind the door of E's choice a bit of candy was concealed. As a control measure, in order to position the candy in a similar manner for each trial a 4½ by 18 inch base was built into the apparatus. This base contained, centered behind each door, a circular well 1 3/4 inches in diameter, with sides curved down to a depth of ¼ of an inch. Because of the

spherical shape of the well, the candy was always found within a small area in the center of the well, and thus always in a similar position relative to the door.

The Reward. Because of different levels of the Ss' sophistication regarding candy, different treatments were applied to Ss according to age. Many of the very younger Ss seemed to know nothing about candy, and had to be taught to appreciate the taste. For this purpose, corn candy was utilized, E holding a piece of this confection in his fingers and passing the tip of the triangularly-shaped candy across the lips and tongue of the S until some response was noted which suggested acceptance of the flavor qualities. For these Ss an entire piece of corn candy was used in the test proper because the size and bright colors of orange, yellow and white permitted easy visibility. On obtaining the candy as a reward, S was permitted to lick the piece of corn candy. A fresh piece of candy was used for each trial. These Ss range in age up to about fifteen months.

For Ss up to about twenty-seven months in age, corn candy cut into bits approximately .2 to .3 inches in diameter was used, while for older Ss a harder candy was used, consisting of small, pastel-colored ovoids measuring approxi-

mately .3 inches in the longest dimension by approximately .2 inches. This differentiation was established because it was found that younger Ss would not accept the harder candy because of difficulty in mastication.

Because of the small size of the candies used, satiation effects were never a problem apparently, even in Ss who received as many as forty pieces of candy during the test. A final extra piece of candy or two was eagerly accepted and consumed by all.

The Tasks. The tasks, or problems of the H-P Test consist of a series of nine graded problems involving both delayed reaction and alternation procedures. Five were used in this study.

Task I. Immediate Reaction. In this task the S sees the placement of the reward behind a predetermined door and is immediately allowed to search. Although labeled "immediate reaction", the task does involve a delay of very short duration.

Task II. Delayed Reaction (Short). In this task the S sees the placement of the reward behind a predetermined door, is turned around bodily through 360 degrees, and then allowed to search. In turning the S, E grasped S by the

shoulders and rotated him slowly, so that the delay involved approximately fifteen seconds.

Task III. Delayed Reaction (Long). In this task the S sees the placement of the reward behind a predetermined door. The S is then seated with back to the apparatus, and read to for one minute. He is then turned to the apparatus and allowed to search.

Task IV. Delayed Reaction (Cued Single Alternation). In this task, the S sees the placement of a red poker chip in front of the middle door. His back is then turned to the apparatus. During this delay interval, the reward is placed behind one of the end doors while the poker chip is moved to a position in front of this same door. The S is then turned to the apparatus and allowed to search for the reward. On the next trial, the reward is placed in a similar manner behind the other end door, producing an alternation sequence together with a delay interval, forming a transitional problem between DR and alternation.

Task V. Single Alternation. Up to this point, S and E are seated together in front of the apparatus. For this task, E takes his place behind the apparatus while S remains in front of the apparatus. E places the reward behind the

end doors alternately without S being aware of where the reward is put. He is then allowed to search.

Ten trials are allowed on any task. Failure on the ten trials is considered failure of the task. If S, however, performs correctly on the tenth trial of any task, he is given an additional trial. If he solves the eleventh trial correctly, it is considered that he has solved the task.

The Transitional Task. Originally the series of tasks included I, II, III and V. On testing Ss during pilot studies, it soon became apparent that the gap between the long DR task and the single alternation task seemed too great. The Presentation Scores achieved indicated no differentiation between Ss in the age range of twenty-eight months to sixty-four months. In order to bridge this gap, the transitional task was developed.

Fifteen Ss, having been tested with Tasks I, II, III and V of the HPCFT by the writer, E_1, were retested subsequent to the creation of the transitional task, by an associate experimenter, E_2, using the sequence, Tasks I, II, III, IV and V. The median test-retest interval was sixty-four days and the range from thirty-eight to seventy-nine

days.

Because of the small number of S̲s, the Spearman rank correlation coefficient was used to determine the correlation between the test and the retest. Table II summarizes the correlation coefficients obtained. It will be noted that the values are in every case high and positive, and that these values are all significant at beyond the .01 level. The value obtained for the relationship between the distributions of Presentation Scores on the tests and the distribution of Presentation Scores on the retest is .839, suggesting that the relationship is relatively close. The transitional task was then made a regular part of the sequence of tasks.

Procedure of Testing. On entering the testing room, Ss were seated comfortably in child-size chairs so that they faced the apparatus at about eye-level. Very young Ss were held on the lap of either the E, or an attendant or mother.

The order of administration followed with each S was Task I, II, III, IV and V consecutively to the point where S failed a task. Testing stopped when a S failed the ten trials of a task. Testing was also discontinued in any task if S made no response of attempting door entries within a

TABLE II

INTERCORRELATIONS BETWEEN DISTRIBUTIONS OF PRESENTATION SCORES AND AGE IN THE TEST-RETEST USED IN DEVELOPING THE TRANSITIONAL TASK, IV

	Correlations (r_s)	P
	Age_1 and PS_1 = .84	$<.01$
Correlation between:	Age_2 and PS_2 = .794	$<.01$
	PS_1 and PS_2 = .839	$<.01$

Age_1 and PS_1, tested by E_1

Age_2 and PS_2, tested by E_2

period of three minutes, and S was counted as having failed that task. This occurred in seven cases.

Careful precautions were taken to guard against visual, auditory and temporal cues to the solution of the tasks. The soundless manipulation of the reward was practiced; between each presentation the gesture of moving the reward from one side of the apparatus to the other was accomplished regardless of the final position of the reward; timing of intervals was made as uniform as possible; variations in the tone of voice used by E were eliminated as much as possible.

Complete directions for administration of the test are to be found in Appendix C.

Quantitative Measures

On record sheets constructed for the purpose, the S's door entries were recorded for each presentation, from door one on E's left to door five on the right. A copy of the record sheets is to be found in Appendix D. From these tabulations the quantitative measures were derived.

The Presentation Score. This score (PS) consists of the total number of correct responses of S prior to the

criterion trials. The criterion for success on each task is two consecutive errorless trials. The number of presentations is ten for Task I. Failure on all ten trials adds ten to a S's PS. Similarly with Tasks II, III and IV. On Task V there are ten trials with two presentations per trial. Failure on all trials adds twenty to a S's PS.

In order to allow for the possibility of the need of the sixth task, a DA task with forty presentations, a total PS was used with a maximum of 100 instead of the standard H-P Test maximum of 290. Failure of Task V indicates a PS of at least sixty. Failure of Task IV indicates a PS of at least seventy. Failure of Task III indicates a PS of at least eighty. Failure of Task II indicates a PS of at least ninety. Failure of Task I indicates a PS of 100.

The Total Errors Score. This score (TE) is the total of all the errors on all the tasks attempted up to the criterion for success. An error is an incorrect door entry. In the case of a S passing the tenth trial of a given task and failing the eleventh, the eleventh is discarded in the scoring.

The Error Index. This score (EI) was devised by Larsen (24) and was intended as a leveling device across

the range of Ss in order to equalize the total number of errors made by the number of opportunities to make errors. For this purpose TE was divided by the number of presentations proffered to the point of failure.

The Pass-Fail Score. This score represents the measure of success in solution of the problem presented by each task. Here, the highest task passed is considered a measure of the S's Pass-Fail Score. To repeat, the criterion of success, or passing any task is achievement of two successive errorless trials.

The use of a time score was not considered because of factors of E's dexterity and Ss' variability. Previous experience with time scores in similar situations (14) proves them unproductive.

The raw scores of each of the above quantitative measures for each S are to be found in Appendix E.

The Intelligence Test

Stanford-Binet Intelligence Test results were available for thirty Ss, twelve of whom are from the test-retest population. The test results were obtained by members of a university class in mental testing as part of their class

work. In every case, the standardized testing procedure, as outlined in the manual (39), was rigidly adhered to. No abbreviated test procedures were utilized.

Table III presents the means, medians and ranges of the mental ages (MA) and intelligence quotients (IQ) that were obtained. It will be noted that a fairly wide range of MA and IQ levels is represented.

The raw scores obtained by the thirty Ss are to be found in Appendix F.

The Educational and Occupational Levels

The data on the highest grade in school completed by the father, as well as the father's occupation, were obtained from an informant in the S's home in every case, most usually the mother. Parenthetically, the birth date of the S was checked at the same time.

The data on the highest grade in school completed by the father were classified into six categories: those whose highest grade completed was the eighth grade or below; some high school, referring to those whose highest grade completed was the ninth, tenth or eleventh; high school graduates, referring to those whose highest grade completed was the

TABLE III

MEANS, MEDIANS AND RANGES OF MENTAL AGES AND INTELLIGENCE QUOTIENTS OBTAINED

Measure	MA	IQ
Mean	4-3.5	115.64
Median	4-5.5	118
Range	2-3 to 5-10	90 to 135

twelfth; some college, referring to those whose highest grade completed was the freshman, sophomore or junior years; college graduates, referring to those who had completed their work for a college degree and those within one month of graduation; and graduate work, referring to those who had completed at least one year of graduate study. Table IV presents the number and percentage of fathers in each educational category.

The occupational data obtained were classified into seven levels, following the pattern used in the Minnesota Scale of Paternal Occupations (3). These levels or classes are: I, professional occupations; II, semi-professional and managerial occupations; III, clerical, skilled trades, and retail business occupations; IV, farmers; V, semi-skilled occupations, minor clerical positions, and minor business; VI, slightly skilled trades and occupations requiring little training or ability; VII, day laborers of all classes including agriculture. Table V presents the distribution of occupational levels of the fathers of the Ss according to this classification, as well as the percentage distribution of occupational levels among the population of employed males in the United States in the 1940 census (3).

TABLE IV

EDUCATIONAL LEVEL OF FATHERS
OF SUBJECTS

Level of Education	Number	Percentage
8th grade and below	3	4.3%
Some high school	8	11.4
High school graduate	21	30.0
Some college	18	25.7
College graduate	15	21.4
One yr. graduate work and up	5	7.2

TABLE V

DISTRIBUTION OF OCCUPATIONAL LEVELS OF FATHERS OF Ss, COMPARED WITH DISTRIBUTION OF OCCUPATIONAL LEVELS OF EMPLOYED MALES IN THE U.S.

Occupational Levels	Fathers of Ss		Employed U.S. Males
	Number	Percent	Percent
I	10	14.3%	2.7%
II	15	21.4	7.2
III	26	37.2	14.1
IV	1	1.4	15.2
V	11	15.7	23.9
VI	6	8.6	14.6
VII	1	1.4	22.3

It will be noted that the distribution of occupational levels in the fathers of the Ss is heavy at the upper levels and light at the lower levels, compared with the distribution of occupational levels in the general population. This suggests that the bulk of the S population comes from upper socio-economic levels, although the range includes all of the seven levels. The raw data on educational and occupational levels are to be found in Appendix A.

Statistical Analysis

The treatment of each quantitative measure retained for analysis, for each of the variables under study, generally made use of correlational methods where possible. Nonparametric methods were used where possible for convenience in computation. Tabular representation of the distributions of Ss according to various measures of the data was utilized to supplement the statistical analysis. Graphic representation was used whenever applicable.

CHAPTER IV

RESULTS

The Age Variable

<u>The Presentation Score</u>. Figure 1 presents the distribution of the Presentation Scores of the seventy individual <u>S</u>s plotted according to CA. It will be noted that the distribution progresses fairly regularly from the high scores to the lower scores, and from the younger age levels to the older. Because of the evident curvilinearity of the distribution, the correlation ratio, eta, was computed which yielded a value of .918, which is significant well beyond the .01 level. A Pearson product-moment correlation coefficient was also computed for this distribution. The value of this coefficient is .876, which is significant well beyond the .01 level. An F test for the significance of the difference between the correlation ratio and the Pearson product-moment correlation coefficient was computed and yielded an F value of 3.65 which is significant at about the .02 level. This suggests that there is a strong tendency for the distribution to be truly curvilinear.

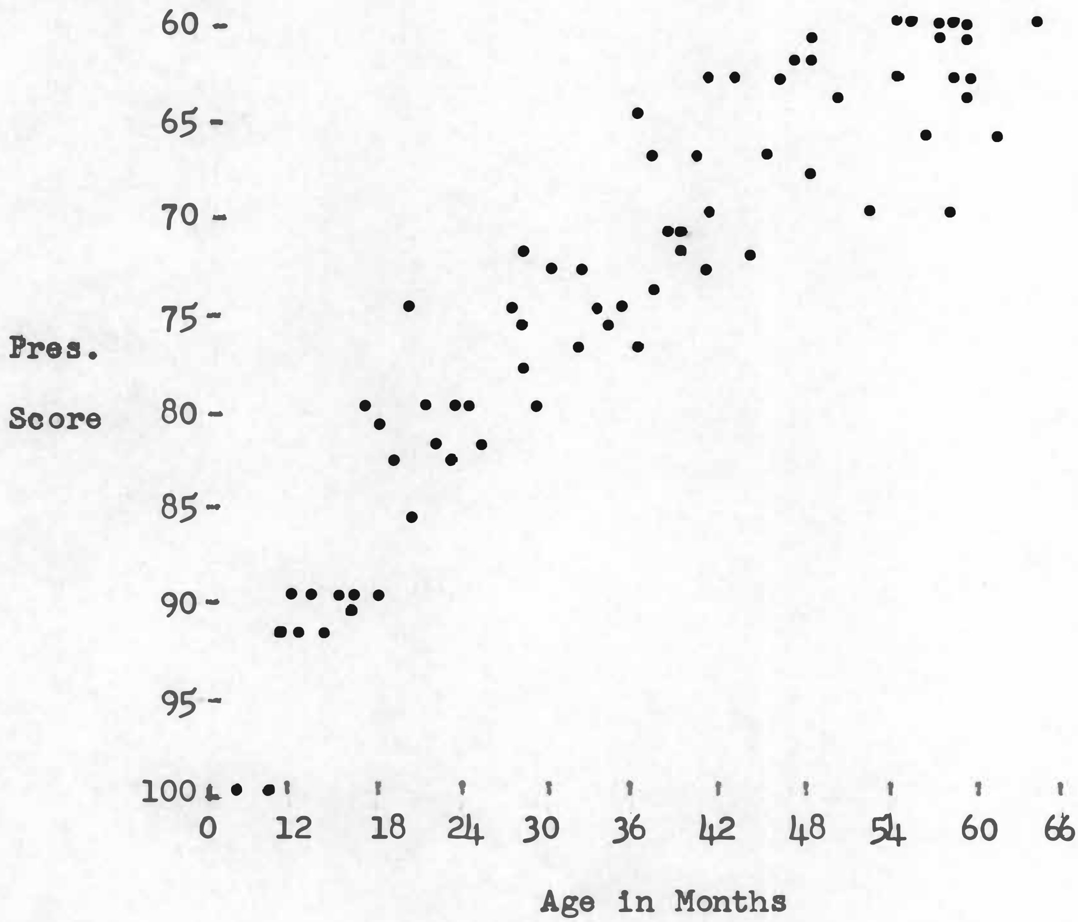

Figure 1. Presentation Scores as a function of chronological age.

The high values obtained for these two correlation coefficients strongly confirm the basic hypothesis of this study, the close relationship between age and the basic measure of performance on the H-P Test, the Presentation Score. Table VI presents these correlations and their associated levels of significance.

Figure 2 presents graphically the medians of the PS distributions across the range of the ages represented by the Ss. The median points have been connected in order to portray the fairly smooth curve of the relationship that has evolved in the course of this study. Table VII presents the means, medians and ranges of the PS of each group of Ss within each age category. It will be noted that the average range is 10.4 PS points, and that this average seems to be typical of every age group but one.

The Total Errors Score. Table VIII presents the distribution of Ss who made various error scores grouped according to PS. In this table several deviant cases are immediately apparent.

Correlation coefficients for the relationship between TE and PS were computed. The correlation ratio obtained between TE and PS is .749, which is significant beyond the .01

TABLE VI

CORRELATION COEFFICIENTS AND THEIR ASSOCIATED LEVELS OF SIGNIFICANCE, FOR THE RELATIONSHIP BETWEEN PRESENTATION SCORES AND CHRONOLOGICAL AGE

Correlation Coefficient	Value	F	P
eta	.918	35.89	$<.001$
r	.876		$<.01$
Significance of the difference between eta and r		3.65	.02

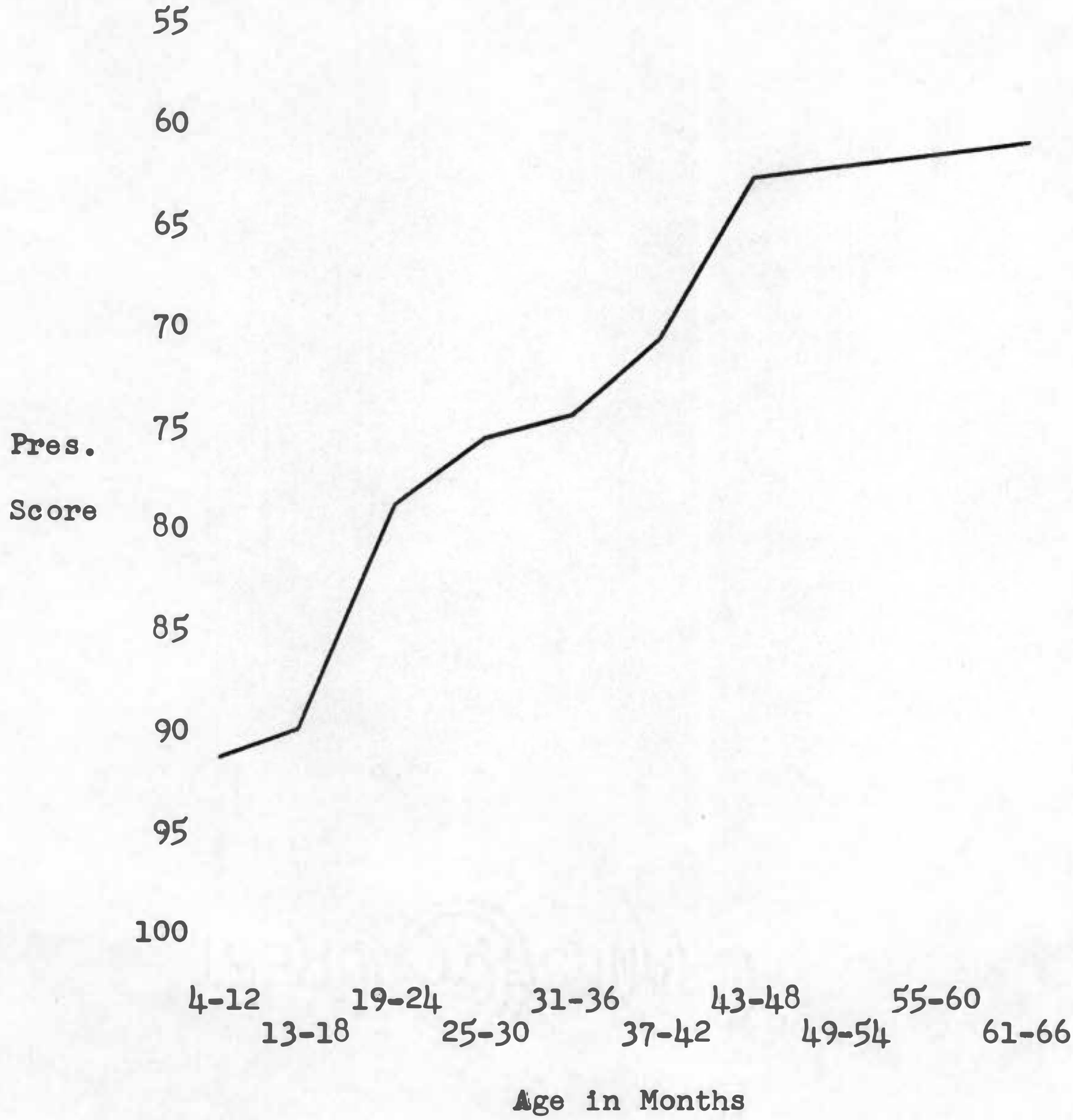

Figure 2. Median Presentation Scores.

TABLE VII

MEANS, MEDIANS AND RANGES OF PRESENTATION SCORES BY CHRONOLOGICAL AGE

		Presentation Scores		
Age in Months	Number	Mean	Median	Range
4-12	5	94.80	92	90-100
13-18	9	88.22	90	80-92
19-24	8	81.00	81	75-86
25-30	7	79.14	76	72-82
31-36	7	74.00	75	65-77
37-42	9	69.89	71	63-74
43-48	8	64.87	63	61-72
49-54	4	64.25	63.5	60-70
55-60	11	63.63	62	60-71
61-66	2	63.00	62.5	60-66

TABLE VIII

DISTRIBUTION OF Ss ACCORDING TO TOTAL ERRORS AND PRESENTATION SCORES

Pres. Score	Total Errors 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
96-100	2									
91-95		4								
86-90		3	2		1	1				
81-85		2	2	1						
76-80		2	4	4						
71-75			7	5	2					
66-70			3		1	3	1			1
61-65			1		4	6	3			
56-60				2	3					

level. The Pearson product-moment correlation coefficient is .618, which is significant beyond the .01 level. The value of these correlation coefficients suggests that considerable relationship exists between the PS and the number of errors made by the Ss. An F test for the significance of the difference between eta and r yielded an F value of 2.466 which is significant at greater than the .05 level, thus suggesting that the relationship between TE and PS is possibly linear.

Table IX presents the distributions of the Ss making various error scores tabulated according to their age in months. Considerable variability is noted when comparing this table with Table VIII.

Correlation coefficients for the relationship between TE and CA were computed. The correlation ratio obtained is .676, which is significant beyond the .01 level. The Pearson product-moment correlation coefficient is .607, which is significant beyond the .01 level. The value of these correlation coefficients suggests that there is a moderate relationship between age and the number of errors made by the Ss. An F test for the significance of the difference between eta and r yielded an F value of 10.66 which is significant well

TABLE IX

DISTRIBUTION OF Ss ACCORDING TO TOTAL ERRORS AND CHRONOLOGICAL AGE

Age in Months	Total Errors 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
4-12	2	3								
13-18		4	4		1					
19-24		3	2	1	1	1				
25-30		1	4	2						
31-36			2	4		1				
37-42			3	3		1	1			1
43-48			1		2	4	1			
49-54			2		1	1				
55-60			1	1	6	1	2			
60 up				1		1				

beyond the .01 level, suggesting that the relationship between TE and CA is possibly linear.

The Error Index. The Error Indices were intended as a leveling device to equalize the error scores made by the various Ss across their opportunities to make errors. Table X presents the tabulations of the distribution of Ss obtaining various EI scores classified according to the TE that each S made. It is immediately apparent from comparing Table X with the distributions presented in Tables IX and VIII that the general shape of the distributions is fairly similar. Apparently the EI operates largely as a reduction in scale and seems to add relatively little to the knowledge gained about the production of errors made by the Ss. Correlation coefficients were computed for the relationship between the distribution of EI and the distribution of TE. The correlation ratio obtained is .692, which is significant beyond the .01 level. The Pearson product-moment correlation coefficients is .599, which is significant beyond the .01 level. This suggests that there is considerable relationship between the EI and TE. An F test for the significance of the difference between eta and r yielded an F value of 2.896 which is significant at just greater than the .05

TABLE X

DISTRIBUTION OF Ss ACCORDING TO ERROR INDICES AND TOTAL ERRORS

Total Errors	Error Index 0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49
0-9	2									
10-19		1	6	4						
20-29			2	5	7	4	1			
30-39				3	5	3	1			
40-49				3	6		1		1	
50-59				1	4	4				1
60 up					1	3		1		

level, and suggests that the relationship between EI and TE is possibly linear. Table XI summarizes the correlation coefficients obtained for the relationships between PS, TE and EI.

<u>Errors in the Failing Task</u>. During the course of the analysis of the data on the number of errors made by each <u>S</u> it immediately became apparent that a number of <u>S</u>s made fewer errors in the last part of the task which they attempted but failed, as compared with the first part of that same task. This suggested the hypothesis that although these same <u>S</u>s failed to pass the task according to the established criterion, apparently some learning occurred. In order to investigate this hypothesis the number of errors each <u>S</u> made in the task he failed was tabulated.

The distribution of the number of <u>S</u>s achieving various numbers of errors in the first and in the second halves of the failing task is tabulated against PS and against CA in Tables XII, XIII, XIV and XV. Comparison of the tabulations presented in these tables suggests that there is a tendency for the distributions to move toward the left, i.e., in the direction of less errors, in the second half of the failing task. This tendency seems to hold up

TABLE XI

CORRELATION COEFFICIENTS AND THEIR ASSOCIATED LEVELS OF SIGNIFICANCE FOR THE RELATIONSHIPS BETWEEN TOTAL ERRORS, ERROR INDICES, CHRONOLOGICAL AGE AND PRESENTATION SCORES

Correlation between:	Coeff-icient	Value	F	P
TE and PS	eta	.749	9.797	$<.01$
	r	.662	-	$<.01$
Significance of difference between eta and r			2.466	$>.05$
TE and CA	eta	.676	5.40	$<.01$
	r	.607	-	$<.01$
Significance of difference between eta and r			10.666	$<.01$
EI and TE	eta	.6924	9.65	$<.01$
	r	.599	-	$<.01$
Significance of difference between eta and r			2.896	$>.05$

TABLE XII

DISTRIBUTION OF Ss ACCORDING TO NUMBER OF ERRORS IN THE FIRST HALF OF FAILING TASK AND PRESENTATION SCORES

Pres. Score	Number of Errors 0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	Medians
96-100	2									4.5
91-95	1	3								
86-90		4	2			1				7.
81-85		4		1						6.
76-80		2	5	1	2					13.
71-75		1	7	4	2					13.
66-70			2	1	5			1		23.
61-65		1		1	2	6	4			26.5
56-60			1	1	1	2				24.

TABLE XIII

DISTRIBUTION OF Ss ACCORDING TO NUMBER OF ERRORS IN THE SECOND HALF OF FAILING TASK AND PRESENTATION SCORES

Pres. Score	Number of Errors 0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	Medians
96-100	2									5.
91-95		3	1							
86-90		2	3		1	1				11.
81-85		3		2						8.
76-80		3	7							10.5
71-75	1	3	7	3						11.
66-70		1	2	3	2				1	16.
61-65	1		2	3	5	3				22.
56-60				5						16.

TABLE XIV

DISTRIBUTION OF Ss ACCORDING TO NUMBER OF ERRORS
IN THE FIRST HALF OF FAILING TASK
AND CHRONOLOGICAL AGE

Age in Months	Number of Errors 0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	Medians
0-12	2	3								5.
13-18		6	2	1						6.
19-24		4	1	1	1	1				9.5
25-30		1	3	2	1					13.
31-36			3	2	1	1				15.
37-42			5	1	1		1	1		13.
43-48		1			3	2	2			25.
49-54		1	1		1	1				17.
55-60			1	2	3	4	1			23.
61 up				1	1					20.5

TABLE XV

DISTRIBUTION OF Ss ACCORDING TO NUMBER OF ERRORS
IN THE SECOND HALF OF FAILING TASK
AND CHRONOLOGICAL AGE

Age in Months	Number of Errors									Medians
	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	
0-12	2	3								5.
13-18		2	5	1	1					13.
19-24		2	1	4		1				15.
25-30	1	3	3							8.
31-36		1	4	1		1				12.
37-42		1	4	1	1	1			1	14.
43-48		1	2	2	3					16.
49-54	1			2	1					16.
55-60			3	5	2	1				18.
61 up				1	1					17.5

whether errors are plotted against PS, or against CA.

Medians for the various distributions are presented graphically in Figures 3 and 4. The median points are connected to produce graphic curves. Comparison of the curves representing the medians of the errors in the first half of the failing task, and the medians of the errors in the second half of the failing task plotted against both PS and CA, presents a very interesting finding. Apparently the number of errors made by the younger Ss is markedly less in the first half of their failing task, as compared with the number of errors made in the second half.

Contrasted with this is the performance exhibited by the older Ss. Here the number of errors made in the first half of the failing task seems to exceed the number of errors made in the second half of the failing task. Apparently, the older Ss exhibited some facility in learning the task, in spite of the fact that they failed to pass the task according to the established criterion. On the other hand, the younger Ss made an increasing number of errors as they progressed through the failing task and thus seem to demonstrate some factor which appears to act like "fatigue."

The medians of the distributions of the errors found

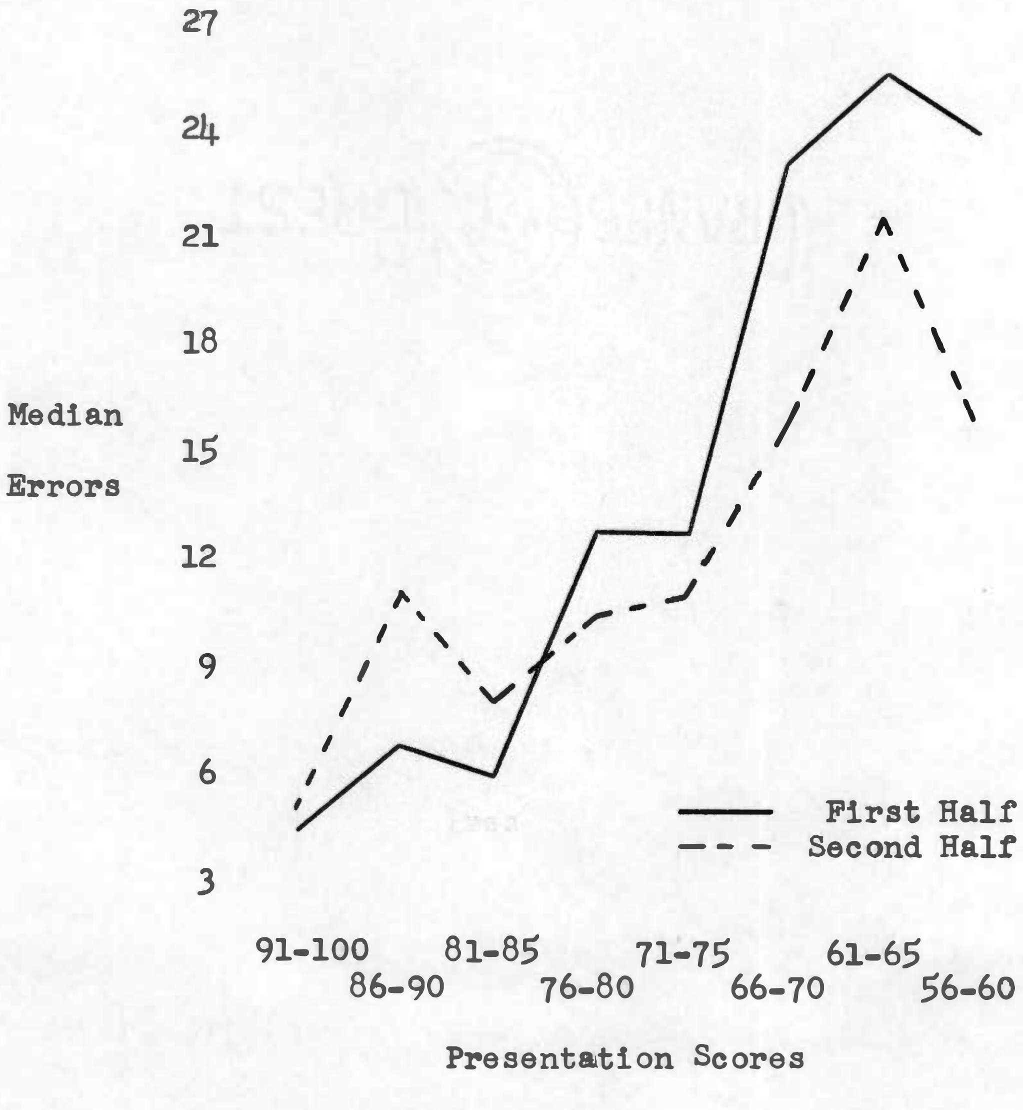

Figure 3. Medians of distributions of errors in the first and second halves of the failing task according to Presentation Scores.

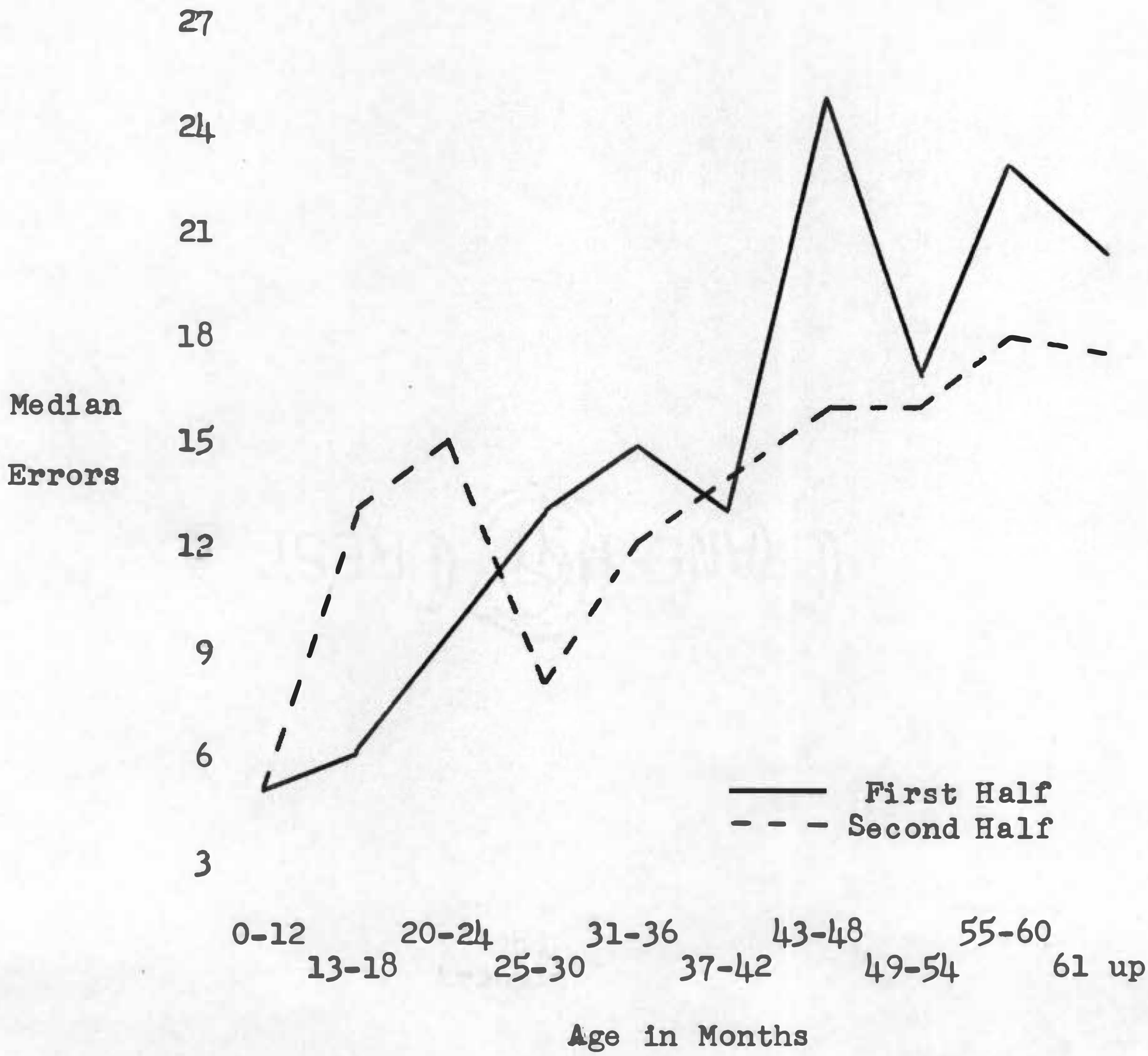

Figure 4. Medians of distributions of errors in the first and second halves of the failing task according to chronological age.

in the first half of the failing task were paired with the medians of the distributions of the errors in the second half, grouped according to both PS and CA. Dividing the distributions of the pairs of the medians into three groups, a group of six low median pairs, six middle median pairs and six high median pairs, provided a basis for comparison by the binomial expansion (22).

In the six low median pairs which represent the youngest Ss, five indicate more errors in the second half of the failing task than in the first half. There is one tie. By the binomial expansion this is an event that can occur with a probability of .057, suggesting that the tendency for the youngest Ss to make more errors in the second half of the failing task approached a significant value. In the middle six pairs of medians, five out of six demonstrate the effect of less errors in the second half of the failing task. One pair of medians demonstrates the effect of more errors in the second half. By the binomial expansion this is an event that can occur with a probability of .109, which suggests that the tendency to make less errors in the second half of the failing task in the middle-most group of Ss is not a significant one. Of the six high pairs of medians, which

represent the oldest group of Ss, all six pairs of medians show the effect of less errors in the second half of the failing task as compared with the first half of the failing task. By the binomial expansion, this is an event which can occur with a probability of .016, which suggests that this effect is highly significant, in this group of Ss.

Correlation coefficients were computed for the relationship between errors in the first half and errors in the second half of the failing task. The correlation ratio obtained is .722, which is significant beyond the .01 level. The Pearson product-moment correlation coefficient is .855, which is significant at beyond the .01 level. These values suggest that a high linear relationship exists. An F test for the significance of the difference between eta and r yielded an F value of -3.174 which is significant at the .04 level, suggesting that there is a good possibility that the relationship is linear. Table XVI summarizes the correlation coefficients obtained for the relationship between errors in the first half and errors in the second half of the failing task.

The Pass-Fail Score. Table XVII presents the distribution of the Ss according to the highest task passed,

TABLE XVI

CORRELATION COEFFICIENTS FOR THE RELATIONSHIP BETWEEN ERRORS IN THE FIRST HALF AND ERRORS IN THE SECOND HALF OF THE FAILING TASK

Correlation Coefficient	Value	F	P
eta	.722	7.23	$<.01$
r	.855		$<.01$
Significance of difference between eta and r		-3.174	.04

TABLE XVII

DISTRIBUTION OF Ss ACCORDING TO HIGHEST TASK PASSED AND CHRONOLOGICAL AGE

Age in Months	Number of Ss	Highest Task Passed 0	I	II	III	IV	V
4-12	5	2	3				
13-18	9		7	2			
19-24	8			7	1		
25-30	7			2	5		
31-36	7				6	1	
37-42	9				6	3	
43-48	8				1	7	
49-54	4				1	3	
55-60	11				1	10	
61-66	2					2	

grouped by age in months. Some overlap is noted between the distributions of the Ss whose highest task passed was II and those whose highest task passed was III. Considerable overlap is noted in the distributions of the Ss whose highest task passed was III and those whose highest task passed was IV.

Table XVIII presents the means, medians and ranges of the age in months of the Ss according to highest task passed.

Figure 5 presents graphically the ranges and the medians of the distributions of ages according to the highest tasks passed. The relatively small amount of overlap between Tasks I and II, and between II and III is portrayed. The relatively large amount of overlap between Tasks III and IV can also be noted.

Correlation coefficients for the relationship between CA and highest task passed were computed. The correlation ratio obtained is .941, which is significant well beyond the .01 level. The Pearson product-moment correlation coefficient is .889, which is significant well beyond the .01 level. These high values suggest that the relationship between CA and highest task passed is very close. An F test for the significance of the difference between eta and r

TABLE XVIII

MEANS, MEDIANS AND RANGES OF DISTRIBUTIONS OF Ss' CHRONOLOGICAL AGES, ACCORDING TO HIGHEST TASK PASSED

	Highest Task Passed					
	0	I	II	III	IV	V
Mean Age	6	12.91	22.36	36.65	51.54	0
Median Age	6	14.5	22	35.5	54	0
Range of Ages	4-8	11-18	17-30	27-58	36-64	0

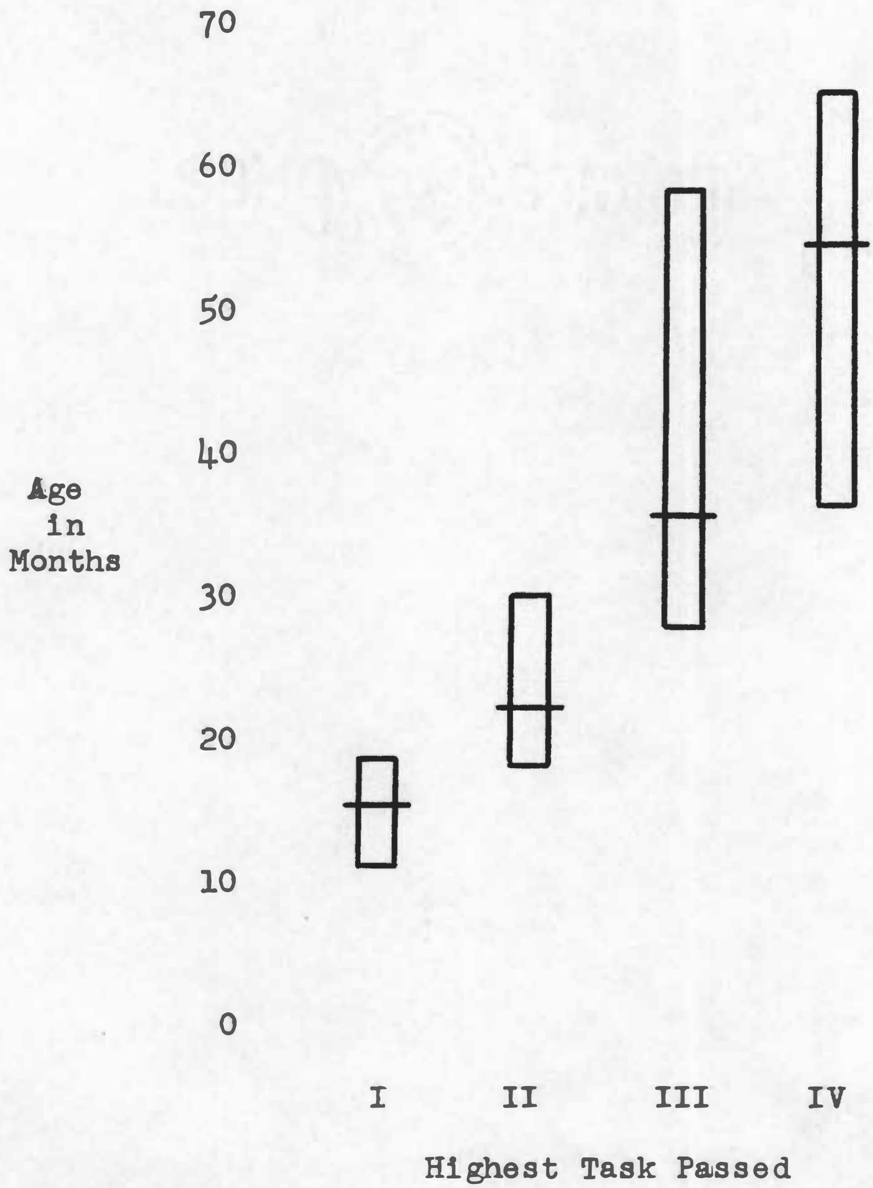

Figure 5. Ranges and medians of the age distributions according to the highest task passed.

yielded an F value of .647 which is not significant, suggesting the possibility that the relationship is linear.

Because of the curvilinear nature of the basic distribution of CA and PS, the entire age distribution was divided into two groups by the median of thirty-five and one-half months. Table XIX presents the mean age in months of the distributions that result from this dichotomy. In the younger age group are found thirty-one _S_s whose highest task passed was I, II and III. In the older age group are thirty-seven _S_s whose highest task passed was III and IV.

Correlation coefficients, $r_{phi/phi\ max}$ (8), were computed for the intercorrelations between these distributions and are presented in Table XX. The correlation coefficients between the highest tasks passed by the younger _S_s are all very small, suggesting that there is little relationship between performance on these tasks. In the older age group the correlation between performance on Task III and that on Task IV is somewhat higher. None of these correlation coefficients approaches significance.

Again, because of the curvilinear nature of the basic relationship between CA and PS, the entire PS distribution was dichotomized by the grand mean of 73.54, excluding the

TABLE XIX

MEAN AGE IN MONTHS OF Ss DIVIDED INTO OLDER AND YOUNGER AGE GROUPS, ACCORDING TO HIGHEST TASK PASSED

		Highest Task Passed			
		I	II	III	IV
Younger Ss	Number	10	11	10	
	Mean Age	14.2	21.82	31.2	
Older Ss	Number			11	26
	Mean Age			41.89	51.54

TABLE XX

INTERCORRELATIONS BETWEEN THE DISTRIBUTIONS OF Ss ARRANGED BY AGE IN MONTHS, AND THE HIGHEST TASK PASSED, AND DICHOTOMIZED INTO YOUNGER AND OLDER AGE GROUPS

	Younger Age Group	
$r_{phi/phi\ max}$ between:	I and II	= .045
	I and III	= .050
	II and III	= .067
	Older Age Group	
$r_{phi/phi\ max}$ between:	III and IV	= .406

two youngest Ss who passed no tasks. Table XXI presents the mean PS of the Ss divided into higher and lower PS groups and classified according to the highest task passed. In the group with higher PS are found the thirty-three Ss whose highest tasks passed were I, II and III. In the group with lower PS are found thirty-five Ss whose highest tasks passed were III and IV.

Correlation coefficients, $r_{phi/phi\ max}$, were computed for the intercorrelations between these distributions and are presented in Table XXII. All four of the correlation coefficients presented are small and confirm the lack of relationship between performance on one task as compared to performance on another. None of the correlation coefficients presented approach significance. No correlation coefficients were computed for tasks which no S in any group passed.

The Intelligence Variable

For thirty of the Ss Stanford-Binet Intelligence Scale results were available. Table XXIII presents the distribution of the Ss according to MA, CA and PS. The Ss range in age from twenty-seven months to fifty-nine months,

TABLE XXI

MEAN PRESENTATION SCORES OF Ss DIVIDED INTO HIGHER AND LOWER PRESENTATION SCORE GROUPS, ACCORDING TO HIGHEST TASK PASSED

		Highest Task Passed			
		I	II	III	IV
Higher PS	Number	10	11	12	
	Mean PS	90.7	81.55	75.17	
Lower PS	Number			9	26
	Mean PS			71.56	63.44

TABLE XXII

INTERCORRELATIONS BETWEEN THE DISTRIBUTIONS OF Ss ARRANGED BY PRESENTATION SCORES, AND THE HIGHEST TASK PASSED, AND DICHOTOMIZED INTO HIGHER AND LOWER PRESENTATION SCORE GROUPS

	Lower Presentation Score	
$r_{phi/phi\ max}$ between:	I and II	= -.061
	I and III	= -.019
	II and III	= .0416
	Higher Presentation Score	
$r_{phi/phi\ max}$ between:	III and IV	= .1005

TABLE XXIII

DISTRIBUTIONS OF Ss ACCORDING TO MENTAL AGE, CHRONOLOGICAL AGE AND PRESENTATION SCORE

		MA			
Age in Months	Number	2-0 to 2-11	3-0 to 3-11	4-0 to 4-11	5-0 to 5-11
21-30	5	5			
31-40	9	1	6	2	
41-50	6			4	2
51-60	10			2	8
PS					
81-85	2		1		1
76-80	3	2		1	
71-75	6	4	2		
66-70	10		1	6	3
61-65	8		2	1	5
56-60	1				1

and in MA from two years, three months to five years, six months. From the tabulation of MA against PS it is evident that the distribution of Ss presents no readily recognizable pattern.

Table XXIV presents the distribution of Ss according to IQ, CA and PS. The IQ range is from 90 to 135. From the tabulation of IQ against PS, again no readily discernible pattern is evident.

Because of the scattered nature of these distributions, Spearman rank correlation coefficients, which require making no assumption regarding the nature of the underlying distribution, were computed for intercorrelations. Table XXV presents the intercorrelations of the distributions of CA, PS, IQ and MA, as well as the probability levels with which they approach significance.

The correlation between the distribution of PS and that of IQ is -.188, and yields a probability value greater than .05 and is thus not significant. This suggests that the relationship between IQ and PS is low and supports the prediction made previously of this relationship. The correlation coefficient obtained between CA and IQ is .002, and is not significant. This suggests that the IQ spread

TABLE XXIV

DISTRIBUTIONS OF Ss ACCORDING TO IQ, CHRONOLOGICAL AGE AND PRESENTATION SCORE

	IQ				
Age in Months	90-99	100-109	110-119	120-129	130-139
21-30	1	1	2	1	
31-40		2	3	3	1
41-50		1	2	2	1
51-60	1	3	3	2	1
PS					
81-85				2	
76-80		1	1	1	
71-75	1	1	3	1	
66-70		3	3	1	3
61-65	1	1	3	3	
56-60		1			

TABLE XXV

INTERCORRELATIONS OF DISTRIBUTIONS OF CHRONOLOGICAL AGES, PRESENTATION SCORES, INTELLIGENCE QUOTIENTS, AND MENTAL AGES

	CA	PS	IQ
Correlations (r_s)			
PS	.651		
IQ	.002	-.188	
MA	.912	.543	.308
P			
PS	< .01		
IQ	> .05	> .05	
MA	< .01	< .01	.05

was relatively even across the range of CA. The correlation between PS and MA is somewhat higher, r_s = .543, and is significant beyond the .01 level, suggesting that there is a moderate relationship between MA and PS. The correlation coefficient obtained between PS and CA in these Ss is .651, and is significant beyond the .01 level. This suggests some tendency to support the original hypothesis of the close relationship between these two variables. The correlation between MA and CA is high, r_s = .912, and is significant well beyond the .01 level, while the correlation between MA and IQ is much lower, r_s = .308, yet significant at the .05 level, suggesting a close relationship between MA and CA and a moderate relationship between MA and IQ.

The Sex Variable

Table XXVI presents the means, medians and ranges of PS according to CA and sex. Forty-one males and twenty-nine females form the total experimental sample. From the tabulation it is evident there are very few large differences between these measures of the distributions of the PS across the male-female dichotomy. In comparing the means of the PS distributions of the male Ss with those of the PS distribu-

TABLE XXVI

MEANS, MEDIANS AND RANGE OF PRESENTATION SCORES BY CHRONOLOGICAL AGE AND SEX

Age in Months	Number		Mean		Median		Range	
	M	F	M	F	M	F	M	F
4-12	3	2	96.7	92	95	92	90-100	92
13-18	4	5	87.8	88.6	90	90	81-90	80-92
19-24	6	2	80.3	83	80.5	83	75-83	80-86
25-30	3	4	76.3	75.3	80	75.5	73-82	72-78
31-36	4	3	75.8	70.7	75.5	73	75-77	65-77
37-42	4	5	68.8	71	68.5	72	67-71	63-75
43-48	7	1	64.4	68	63	68	61-72	68
49-54	1	3	60	66	60	65	60	63-70
55-60	7	4	63	65.2	63	65.5	60-71	60-70
61 up	2		63		63		60-66	
	41	29						

tions of the female Ss, an F_{range} (22) value was obtained of .634 which is not significant. This suggests that the differences between sexes is relatively insignificant.

A correlation coefficient, $r_{phi/phi\ max}$, was obtained for the relationship between PS and sex. The value of this coefficient is .019, which is small, suggesting that there is little or no relationship between sex and PS. A correlation coefficient, $r_{phi/phi\ max}$, was obtained for the relationship between sex and TE. The value of this coefficient is -.035, which is again very small, suggesting the almost total lack of relationship between sex and the making of errors.

Correlation coefficients were computed for the relationship between PS and CA for girls alone. The correlation ratio obtained is .914, which is significant well beyond the .01 level. The Pearson product-moment correlation coefficient is .881, which is significant well beyond the .01 level. An F test for the significance of the difference between eta and r yielded an F value of 10.14 which is significant beyond the .01 level. These three values are all very similar to those obtained in computing correlation coefficients for the relationship between PS and CA over the

entire experimental group, and the same conclusions can be drawn regarding the closeness of the relationship between CA and PS.

Similarly with male Ss, the correlation ratio for the relationship between PS and CA is .866 and is significant beyond the .01 level. The Pearson product-moment correlation coefficient for the same distribution is .899 which is significant beyond the .01 level. An F test for the significance of the difference between eta and r yielded an F value of -.9133 which is not significant. Again, the values obtained for the relationship between PS and CA for male Ss alone is reminiscent of those obtained for the entire population, and leads to similar conclusions of the close relationship between these two distributions.

To test the hypothesis that these two sets of correlation coefficients differ significantly, z transformations were computed. For the test of the significance of the difference between the eta_M and eta_F a z value was obtained of .094. This value represents only a very small deviation from the mean of the general population and suggests that the difference between the two correlation ratios is highly insignificant. To test the hypothesis of the significance

of the difference between r_M and r_F a z value was obtained of .035. This value again represents a very small deviation from the mean of the general population and thus suggests that the differences between the two correlation coefficients is highly insignificant. Table XXVII summarizes these correlation coefficients.

The Education Variable

Table XXVIII depicts the distribution of Ss according to the highest grade in school completed by the father, and the PS of the Ss. The distribution of highest grades of school has been divided into six categories. Twenty-one fathers are high school graduates, and the majority, thirty-eight, have had at least some college work. Apparently the distribution as tabulated is fairly widely dispersed and there seems to be no discernible pattern evident.

The Pearson product-moment correlation coefficient for this relationship is .084, which is not significant. This suggests that there is very little relationship between PS and the educational level of the fathers of the Ss.

TABLE XXVII

CORRELATION COEFFICIENTS OBTAINED FOR RELATIONSHIPS BETWEEN SEX AND PRESENTATION SCORES, TOTAL ERRORS AND CHRONOLOGICAL AGE

	$r_{phi/phi\ max_{PS\ and\ sex}}$	= .0194		
	$r_{phi/phi\ max_{TE\ and\ sex}}$	= .035		
Male Ss	$eta_{PS\ and\ CA}$	= .866	F = 10.296	P = $<$.01
	$r_{PS\ and\ CA}$	= .899		P = $<$.01
Female Ss	$eta_{PS\ and\ CA}$	= .914	F = 12.673	P = $<$.01
	$r_{PS\ and\ CA}$	= .881		P = $<$.01
Significance of difference between eta_M and eta_F		z = .095		P = $>$.05
Significance of difference between r_M and r_F		z = .035		P = $>$.05

TABLE XXVIII

DISTRIBUTION OF Ss ACCORDING TO HIGHEST GRADE IN SCHOOL COMPLETED BY FATHER AND PRESENTATION SCORE

	Educational Level					
Pres. Score	8 & below	Some H.S.	H.S. Grad.	Some Coll.	Coll. Grad.	Grad. Wk.
96-100				1	1	
91-95	1		1		2	
86-90		1		3	3	
81-85		1		2	2	
76-80		1	5	3	1	
71-75	1	2	4	2	4	1
66-70	1	1	2	3		2
61-65		1	7	4	2	
56-60		1	2			2
Totals:	3	8	21	18	15	5

The Occupational Variable

Table XXIX depicts the distribution of the Ss in each occupational level, classified according to the occupations of their fathers and PS. From the tabulation it is seen that a large proportion of the fathers fall under the Class III occupational level, the category of clerical workers, skilled trades and retail business. Only one farmer and one day laborer are found in the tabulation.

A Pearson product-moment correlation coefficient for the relationship between the PS of the Ss and the occupational level of the father is -.125 which is not significant. This slightly negative value for the relationship between these two variables suggests the conclusion that the relationship is negligible. Table XXX summarizes this correlation coefficient as well as that related to the education variable.

Differences between the Obtained Correlations

To test the hypothesis that there are significant differences between the major correlation coefficients obtained in the study, a series of z transformations were

TABLE XXIX

DISTRIBUTION OF Ss IN EACH OCCUPATIONAL LEVEL GROUP ACCORDING TO OCCUPATION OF FATHER AND PRESENTATION SCORE

Pres. Score	Occupational Level I	II	III	IV	V	VI	VII
96-100		2					
91-95		2	1	1			
86-90	1	2	3			1	
81-85	2		2		1		
76-80	1	2	5		1	1	
71-75	1	3	6		2	2	
66-70	2	1	2		2	1	1
61-65	2	2	5		4	1	
56-60	1	1	2		1		
Totals:	10	15	26	1	11	6	1

TABLE XXX

CORRELATION COEFFICIENTS OF THE RELATIONSHIPS BETWEEN EDUCATIONAL AND OCCUPATIONAL LEVELS OF FATHERS, AND PRESENTATION SCORES

Correlation Coefficient	Value	P
r_{PS} and educational level	.084	$>.05$
r_{PS} and occupational level	-.125	$>.05$

computed. These are summarized in Table XXXI, together with their associated levels of significance. It will be noted that the first four z values are highly significant, suggesting that there are marked differences between the correlation coefficients represented. The final five z values are small and are insignificant, suggesting that the differences between these correlation coefficients represented are relatively small.

TABLE XXXI

DIFFERENCES BETWEEN THE OBTAINED CORRELATION COEFFICIENTS

Significance of difference between:	z	P
$r_{CA,PS}$ and $r_{PS,educ.\ level}$	7.37	$<.001$
$r_{CA,PS}$ and $r_{PS,occup.\ level}$	8.58	$<.001$
$r_{CA,PS}$ and $r_{PS,IQ}$	6.79	$<.001$
$r_{CA,PS}$ and $r_{PS,sex}$	7.74	$<.001$
$r_{PS,IQ}$ and $r_{PS,educ.\ level}$	1.20	$>.05$
$r_{PS,IQ}$ and $r_{PS,occup.\ level}$	1.39	$>.05$
$r_{PS,IQ}$ and $r_{PS,sex}$	1.21	$>.05$
$r_{PS,sex}$ and $r_{PS,educ.\ level}$	.37	$>.05$
$r_{PS,sex}$ and $r_{PS,occup.\ level}$	.84	$>.05$

CHAPTER V

DISCUSSION

The present study sought to confirm the assumption that concept formation behavior is largely a function of chronological age in pre-school children. To this end a test of concept formation based upon classic methods used in research in this area was employed.

The basic assumption around which the study was organized was confirmed, and a high positive correlation was found between CA and concept formation behavior. This high positive correlation was found on almost all the test measures used, in the Presentation Score, in the number of errors, and in the number of tasks passed. Several variables were found to have relatively little relationship with concept formation behavior. These were, intelligence as measured by a standard intelligence scale, sex, and father's educational and occupational levels.

The predictions made in the introductory chapter have nearly all been confirmed by the results of the study. The correlation between concept behavior and CA was found to be high and positive as predicted. The correlation

between concept behavior and socio-economic status as measured by the educational and occupational levels of the fathers of the Ss was found to be low as predicted, but slightly negative. The correlation between concept behavior and intelligence was found to be low as predicted, but slightly negative. The relationship between concept behavior and a third variable, sex, was found to be low and positive as predicted. Further, the differences between these correlations was found to be significant at high levels, as predicted, i.e., a highly significant difference was found between the correlation of concept behavior and CA as compared with the correlation of concept behavior and the other variables investigated. No significant differences were found between the correlations of concept behavior and socio-economic status, intelligence, or sex, as predicted.

The moderate correlation found between MA and PS appears to be a function of the fact that both MA and PS are highly correlated with CA. The moderate correlation that is found between TE and PS, seems again to be a function of the age variable, in so far as older children succeed at more tasks than younger children and thus have more opportunities to make errors.

At this point, the use of error scores seems to add relatively little to the discriminatory value of the H-P Test as compared to the PS. The EI, in particular, seems to add little more than a reduction in scale. There is, however, considerable research value in error scores. The detection of differential behavior on the failing task in younger and older Ss in the experimental sample, came from study of the error patterns.

Again, examination of errors in the failing task of the seven Ss who were scored "no response within three minutes" as compared with the failing task of other Ss revealed an interesting fact. In the thirty-two trials of the failing task performed by the no-response children, there was but one errorless trial although the expected frequency is 6.4 errorless trials. Thirteen other Ss of the same age levels produced twenty-one errorless trials of an expected twenty-six. These data yielded a Chi Square of 5.5 which is significant at the .02 level, suggesting a considerable difference in performance, with implications for the further investigation of this aspect of H-P Test performance in terms of schedules of reinforcement. It seems possible that the "no response" Ss were operating, in the failing task, on an

aperiodic reinforcement schedule different than that of their age-mates. Another point to consider about this behavior is that the significance of the Chi Square value lends support to the a priori decision to count "no response within three minutes" as a bona fide failure. Apparently the cessation of response is a genuine response to the difficulty of the task and not a superficial loss of interest.

The use of the highest task passed as a acore seems also weak in discriminating among Ss, as compared with PS. The degree of overlap seen in Figure 5 testifies to this point.

Two aspects of the study which might be considered replicative in their effects in supporting the assumptions made, are the test-retest situation carried out by E_1 and E_2, and the male-female dichotomy. Both of these features of the study yielded high positive correlations suggesting considerable support for the basic assumption of the close relationship between concept behavior and CA.

The fact that nearly all the Ss in the sample were pupils in nursery schools is a point to consider in terms of the effect on the results found. In general, the results appear to be remarkably homogeneous, and it seems possible that this may be a reflection of the homogeneity of the

experimental sample. During the course of the testing in the nursery schools it was noted that the children receive considerable training and stimulation. One important aspect is an emphasis on socialization, so that these children seemed to be relatively comfortable in relationships with others. Apparently this had a favorable effect on test rapport, and served to promote testing. Very seldom was a pupil of the nursery schools found to be difficult to work with. Another point is that considerable formalized training and education takes place in these nursery schools, leading to what may be a learning "set", which again might have the effect of facilitating homogeneity. Comparison of the H-P Test performance of children with no nursery school experience with that of nursery school pupils might provide some experimental evidence regarding these variables.

The effect of the measuring instrument, the H-P test, as a factor in facilitating such homogeneity cannot be discounted. Comparison of H-P Test performance in a broadly heterogeneous sample of Ss with that of a homogeneous sample like that of the present study can provide evidence regarding this point.

It seems unlikely that the differential treatments

accorded the Ss as regards the reward, had any great effect on the test performance. It would seem logical that any differential treatment would have the effect of producing some degree of heterogeneity, which is not very evident in these data. What effect actually exists, is an experimental question.

Some qualification regarding the findings concerning the intelligence variable are in order because of the relative inexperience of the examiners. As members of a beginning class in mental testing, there is reason to expect some degree of unreliability in these results. As a point in their favor, however, the case of S forty-eight can be cited, to whom the intelligence test was administered by two different examiners on two separate occasions with a high degree of agreement. The first examiner obtained an IQ of 110 while the second, four days later, obtained an IQ of 106. The factor of inexperience cannot be minimized, however, and these data are to be considered suggestive, rather than conclusive.

Although the EI as a leveling device was relatively unsuccessful, the establishment of a score which would permit comparison of test performance of individuals of dif-

ferent age levels seems desirable. As it stands, to make such a comparison involves some sort of cumbersome comparison between estimates of performance relative to that of others of the same age levels. What is wanted is a quotient, something similar to those used in several of the popular intelligence scales.

Some tentative ideas on such a score seem in order. The number of trials possible to any S in any task passed is ten, excluding the first trial. Arbitrarily setting the mid-point of these trials equal to 100, can provide a scale of ten equal-appearing intervals of ten points each, ranging from fifty-five at trial eleven to 145 at trial two. The performance of each S, on each task passed, can be graded or scaled on this arbitrary scale, i.e., a S who passed Task I with two errorless trials receives a score of 145 on that task, if he passed Task II by the fourth trial would be scored 125 on Task II, and if he passed Task III by the eighth trial would be scored 85 on Task III. Adding these scores and dividing by an arbitrary number called "the number of tasks should have passed", would provide a quotient which would permit comparing performances on the basis of the ratio of actual performance to expected

performance. In the example, if "the number of tasks should have passed" were three, the resulting quotient would be 118. This seems to be the sort of score that is required. It should be noted that such a quotient is based on two assumptions. One is the setting of the arbitrary scale at the task mid-point as outlined above, and the other is the assumption underlying the "number of tasks should have passed". Although these two aspects are here described as arbitrary, in practice these should be based on experimentation to determine what values to assign.

Consideration of the findings of this study suggest other implications for further research. Because of the relatively small number of Ss at each age level, these findings can be considered to be only suggestive of normative information on the H-P Test behavior of normal pre-school children. The findings are further restricted by the limitations of the experimental sample in terms of geographic area, race, and socio-economic status. The use of larger stratified samples, considering these and other variables, would provide H-P Test norms more representative of the general population of normal pre-school children.

From this step, it seems logical to make the next

step of comparing H-P Test performance of non-normal children with that of normal children to establish patterns of deviancy, and to aid in further study of thought processes. Another problem that presents itself is that of comparing the H-P Test performance of twins, identical and fraternal, as well as the performance of siblings, to provide information on genetic factors in thought processes. Still another problem is the study of the effect of retesting Ss over varying spans of time to provide some information on H-P Test reliability, recall, and E reliability.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Seventy normal pre-school children were selected for the present study. The age range of the subjects was four months to sixty-four months. All but five were pupils of four nursery schools in Knoxville, Tennessee. Three were seen in a day-care home and two were seen at home. All Ss were of the white race. No S was selected within one hour after having had food.

Data on the chronological age and sex of each S was obtained, as well as information on the education and occupation of the father of each S. For thirty Ss Stanford-Binet Intelligence Scale results were obtained.

The Hunter-Pascal Concept Formation Test was administered to each S by the experimenter. The test consists of nine graded problems or tasks embodying the principles of delayed reaction, single alternation, and double alternation. Five of these were used in this study, an immediate reaction task which involves a very short delay, a short delayed reaction task which involves a delay of approximately fifteen seconds, a long delay task which involves a

delay of one minute, a cued single alternation task which combines a delay with alternation, and a single alternation task.

The Ss were tested according to standardized procedures, using small pieces of candy as a reward. Performance was recorded for each of four quantitative indices: Presentation Score, Total Errors Score, Error Index Score, and Highest Task Passed. The Presentation Score was found to be the most discriminative.

Performance on each measure was analyzed to determine the effects of the variables of chronological age, intelligence, and sex of the Ss, and educational and occupational levels of the fathers of each S, and the relationships existing between these variables.

The analysis was accomplished by correlational techniques in the main, together with tabular and graphic presentation.

The findings support the following conclusions about this relatively homogeneous sample of pre-school children:

1. There is a close relationship between chronological age and concept formation behavior as measured by the H-P Test.

2. There is little relationship between concept formation behavior and the variables of sex, intelligence, and socio-economic status as measured by the father's education and occupation.

3. Chronological age seems to be the most important determinant in concept formation behavior.

4. The development of concept formation behavior in pre-school children is orderly and progressive along maturational lines.

Some conclusions about the H-P Test are warranted:

1. The test offers a valid method of investigating conceptual processes of pre-school children, especially in the study of the development of such processes.

2. The test offers considerable possibilities for research into a number of aspects related to the learning problems involved in the conceptual process.

3. Children sixty-four months old and younger seem unable to solve the single alternation task of the H-P Test.

4. The test holds promise of development into a valid method of clinically appraising conceptual abilities in young children.

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APPENDICES

APPENDIX A

APPENDIX A

S's AGE AND SEX; FATHER'S HIGHEST GRADE COMPLETED IN SCHOOL, OCCUPATION, AND OCCUPATION LEVEL

			Educational and Occupational Data on Father		
Subject	Age	Sex	Highest Grade Completed	Occupation	Occupational Level
1	4	M	15	Student, Indust. Mgmt.	II
2	8	M	16	Student, Agric.	II
3	11	F	4	Farmer	IV
4	12	M	16	Student, Bus. Adm.	II
5	12	F	16	Student, Indust. Mgmt.	II
6	13	M	15	Student, Accounting	II
7	14	F	12	Clerical Worker	III
8	15	F	10	Knitting Machine Operator	VI
9	15	M	14	Salesman, Surgical Supplies	III
10	16	F	16	Student, Phys. Ed.	II
11	16	M	14	Salesman, Wholesale Drugs	III
12	17	F	12	TV Cameraman	III
13	18	F	16	Elec. Engineer	I
14	18	M	13	Salesman, Advertising	III

APPENDIX A (continued)

S's AGE AND SEX; FATHER'S HIGHEST GRADE COMPLETED IN SCHOOL, OCCUPATION, AND OCCUPATION LEVEL

			Educational and Occupational Data on Father		
Subject	Age	Sex	Highest Grade Completed	Occupation	Occupational Level
15	19	M	16	Student, Engineering	I
16	19	F	16	Salesman	III
17	20	M	12	Clerical Worker	III
18	21	F	13	Student, Education	II
19	22	M	11	Machine Operator, Metals	V
20	23	M	16	Student, German	I
21	23	M	15	Draftsman	III
22	24	M	11	Army, Pvt.	VI
23	25	M	16	Student, Med.	I
24	27	F	10	Policeman	V
25	28	F	12	Clerical Worker	III
26	28	F	13	Salesman, Insurance	III
27	28	F	8	Marble Worker	VI
28	29	M	12	Salesman, Wholesale Food	III

APPENDIX A (continued)

S's AGE AND SEX; FATHER'S HIGHEST GRADE COMPLETED IN SCHOOL, OCCUPATION, AND OCCUPATION LEVEL

			Educational and Occupational Data on Father		
Subject	Age	Sex	Highest Grade Completed	Occupation	Occupational Level
29	30	M	12	Salesman, Insurance	III
30	32	F	12	Salesman, Advertising	III
31	32	F	14	Mgr., Boat Service	III
32	34	M	15	Officer, Army Artillery	II
33	35	M	16	Student, Agric.	II
34	35	M	12	Salesman, Wholesale Drugs	III
35	36	M	12	Piano Tuner	V
36	36	F	16	Student, Geology	I
37	37	M	12	Accountant	III
38	37	F	18	College Instructor	I
39	38	F	12	Auto Mechanic	V
40	39	M	14	Salesman, Auto Supplies	III
41	39	F	16	Musician	II
42	40	M	14	Boiler Operator	V

APPENDIX A (continued)

S's AGE AND SEX; FATHER'S HIGHEST GRADE COMPLETED IN SCHOOL, OCCUPATION, AND OCCUPATION LEVEL

Subject	Age	Sex	Educational and Occupational Data on Father: Highest Grade Completed	Occupation	Occupational Level
43	41	F	16	Mining Engineer	I
44	41	F	11	Machine Operator, Plastics	VI
45	41	M	18	Entomologist	I
46	43	M	15	Asst. Mgr., Car Rental	III
47	44	M	16	Federal Agent	II
48	45	M	14	Student, Bus. Adm.	II
49	46	M	12	Knitting Machine Operator	VI
50	47	M	13	Student, Elec. Eng.	II
51	48	M	12	Salesman, Wholesale Hdware	III
52	48	M	12	Chemical Operator	V
53	48	F	15	Clerical Worker	III
54	50	F	12	Grocery & Hardware Clerk	V
55	52	F	12	Cake Baker	V
56	54	F	11	Iron Worker	V

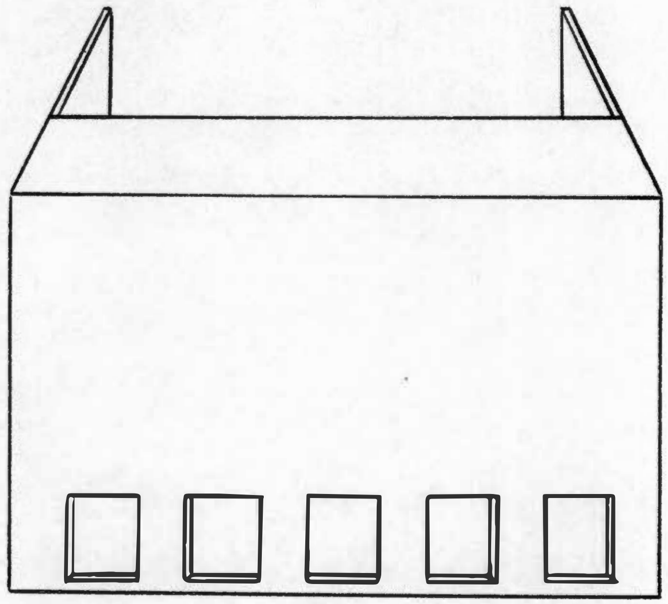
APPENDIX A (continued)

S's AGE AND SEX; FATHER'S HIGHEST GRADE COMPLETED IN SCHOOL, OCCUPATION, AND OCCUPATION LEVEL

			Educational and Occupational Data on Father		
Subject	Age	Sex	Highest Grade Completed	Occupation	Occupational Level
57	54	M	19	Physician	I
58	55	M	15	Student, Pre-Medical	II
59	56	F	11	Army, Pvt.	VI
60	57	F	11	Mechanic	V
61	58	M	16	Prop., Retail Business	III
62	58	M	15	Salesman, Iron Works	III
63	58	F	8	Miner, Driller	VII
64	58	M	12	Tax Inspector	III
65	59	M	12	Tax Inspector	III
66	59	M	12	Postal Clerk	V
67	59	M	12	Draftsman	III
68	59	F	12	Salesman	III
69	62	M	19	Accountant, CPA	I
70	64	M	18	Ag. Ed. Specialist	II

APPENDIX B

APPENDIX B



In outside dimensions the apparatus is 18 inches long by 12 inches high by 4 inches deep, with wings 8½ inches wide. The doors are 2½ by 3½ by 3/4 inches. The door entries are slightly smaller than these dimensions.

APPENDIX C

APPENDIX C

DIRECTIONS FOR ADMINISTERING THE HUNTER-PASCAL CONCEPT FORMATION TEST

1. The apparatus is placed near the edge of a low table or bench. The S is seated comfortably so that he is opposite the middle door, and within easy reach of the apparatus. For Tasks I, II, III and IV, E sits with the S in front of the apparatus.

2. E says, "This is my candy house. I call it a candy house because little boys and girls get lots of candy from behind these doors. See the little doors? Go ahead, try to open them." The S is encouraged to open and shut all the doors several times to familiarize himself with the mechanics of the apparatus. If the child wishes to look around at the back of the apparatus, this is permitted. A piece of candy is then offered to the S and he is encouraged to eat it immediately. E asks, "Do you want another piece? Let's see if you can remember where it is, if I put it behind this door." E places candy behind the predetermined door, taking care that the S's attention is held and that he is visually following the candy until the door closes over it. E says, "Go ahead, find the candy", and encourages

APPENDIX C (continued)

DIRECTIONS FOR ADMINISTERING THE HUNTER-PASCAL CONCEPT FORMATION TEST

the S to reach for the door and obtain and eat the candy.

3. For Task II, the chair is pulled back a few inches so that the child can stand in front of the apparatus. The candy is placed while the S watches. Immediately the door closes, the S is grasped by the shoulders and rotated slowly through 360 degrees so that the rotation consumes approximately fifteen seconds. E says, "Find the candy".

4. For Task III, the S again watches while the candy is placed, then is turned so his back is towards the apparatus. The child is then read to from some standard book of nursery rhymes. At the end of one minute, the child is turned toward the apparatus and allowed to search, E saying, "Find the candy".

5. For Task IV, S watches while a red poker chip is placed in front of the middle door, then is turned so his back is towards the apparatus. While E holds the S's head with his right hand, to prevent visual cues, with his left hand the E places the candy behind the predetermined door, then moves the poker chip in front of that door. E releases

APPENDIX C (continued)

DIRECTIONS FOR ADMINISTERING THE HUNTER-PASCAL CONCEPT FORMATION TEST

his grasp, and turns S toward the apparatus, saying, "Find the candy."

6. For Task V, the E moves around behind the apparatus while the S remains seated in front of the apparatus and well within reach of it. E says, "Now I am going to hide this piece of candy behind one of these doors, and I want you to look for it as fast as you can. See if you can find the candy the first door you open. As soon as you find the candy you can eat it. Are you ready? Shut your eyes tight." E places the reward behind the predetermined door, then says, "All right. Open your eyes. Find the candy."

7. Precautions are taken to avoid giving cues to S regarding the placement of the reward. The door entries are recorded by number in the space provided on the record sheets.

Considerable encouragement is required to get some children started on the test. These directions are to be adhered to as a general outline, rather than rigidly. For very young Ss very little verbalization on the part of the

APPENDIX C (continued)

DIRECTIONS FOR ADMINISTERING THE HUNTER-PASCAL CONCEPT FORMATION TEST

E is required, while shy Ss require considerable encouragement and friendliness. A little effort expended in making the test procedure a fast-moving game seems to be extremely beneficial for promoting test performance.

APPENDIX D

HUNTER - PASCAL CONCEPT FORMATION TEST RECORD B. D. KAIMAN

Name			
Sex Race			
Place			
	Year	Mo.	Day
Date			
Birth Date			
Age			
Comments			

II - DELAYED REACTION (SHORT)

T #	Door	Doors Opened	E
1	3		
2	5		
3	4		
4	1		
5	3		
6	4		
7	3		
8	2		
9	5		
10	2		
11	4		

I - IMMEDIATE REACTION

T #	Door	Doors Opened	E
1	2		
2	1		
3	3		
4	4		
5	5		
6	3		
7	5		
8	2		
9	4		
10	1		
11	3		

III - DELAYED REACTION (LONG)

T #	Door	Doors Opened	E
1	3		
2	2		
3	4		
4	5		
5	1		
6	3		
7	2		
8	4		
9	5		
10	2		
11	1		

IV - DELAYED REACTION (CUED)

T #	Door	Doors Opened	E
1	5		
2	1		
3	5		
4	1		
5	5		
6	1		
7	5		
8	1		
9	5		
10	1		
11	5		

V - SINGLE ALTERNATION

T #	Door	Doors Opened	E
1	1		
	5		
2	1		
	5		
3	1		
	5		
4	1		
	5		
5	1		
	5		
6	1		
	5		
7	1		
	5		
8	1		
	5		
9	1		
	5		
10	1		
	5		
11	1		
	5		

APPENDIX E

APPENDIX E

RAW SCORES OBTAINED BY SUBJECTS ON H-P TEST

Subject	Pres. Score	Highest Task Passed	Total Errors	Error Index	Errors Failing Task First Half	Errors Failing Task Second Half
1	100	0	0	0	0	0
2	100	0	0	0	0	0
3	92	I	12	1	5	5
4	90	I	14	1.4	5	9
5	92	I	16	1.3	6	8
6	90	I	14	1.4	5	9
7	92	I	11	.9	5	5
8	90	I	16	1.6	5	11
9	90	I	20	2.0	7	13
10	91	I	19	1.7	4	14
11	90	I	22	2.2	12	10
12	80	II	20	2.5	13	13
13	90	I	41	4.1	18	23
14	81	II	22	2.0	6	15

APPENDIX E (continued)

RAW SCORES OBTAINED BY SUBJECTS
ON H-P TEST

					Errors Failing Task	
Subject	Pres. Score	Highest Task Passed	Total Errors	Error Index	First Half	Second Half
15	83	II	39	3.0	7	15
16	86	II	56	4.6	29	29
17	75	III	46	3.0	22	16
18	80	II	15	1.5	9	6
19	81	II	21	3.0	15	15
20	80	II	15	1.5	7	8
21	83	II	14	1.1	5	7
22	80	II	22	2.2	10	12
23	82	II	15	1.3	6	8
24	75	III	27	1.8	18	4
25	76	III	34	2.1	13	13
26	78	III	39	2.2	20	10
27	72	III	21	1.8	12	7
28	80	II	28	2.8	17	11

APPENDIX E (continued)

RAW SCORES OBTAINED BY SUBJECTS
ON H-P TEST

Subject	Pres. Score	Highest Task Passed	Total Errors	Error Index	Errors Failing Task First Half	Errors Failing Task Second Half
29	73	III	24	1.8	12	8
30	77	III	31	1.8	14	9
31	73	III	37	2.8	19	16
32	76	III	25	1.6	10	10
33	75	III	30	2.0	13	13
34	75	III	29	2.1	15	10
35	77	III	39	2.2	20	12
36	65	IV	59	2.4	25	27
37	67	IV	60	2.3	24	22
38	74	III	34	2.4	12	14
39	71	III	33	2.8	13	18
40	71	III	21	1.2	10	9
41	72	III	30	2.5	18	10
42	67	IV	96	3.7	39	44

APPENDIX E (continued)

RAW SCORES OBTAINED BY SUBJECTS
ON H-P TEST

					Errors Failing Task	
Subject	Pres. Score	Highest Task Passed	Total Errors	Error Index	First Half	Second Half
43	63	IV	59	2.7	31	26
44	74	III	28	2.0	13	10
45	70	III	24	2.2	12	12
46	63	IV	51	2.3	34	12
47	72	III	22	1.8	8	12
48	67	IV	45	1.7	23	5
49	64	IV	60	2.5	26	24
50	62	IV	42	1.9	24	16
51	61	IV	57	2.7	31	24
52	62	IV	53	2.5	27	20
53	68	IV	51	1.9	23	16
54	64	IV	27	1.1	8	4
55	70	III	26	2.6	10	16
56	63	IV	57	2.5	27	23

APPENDIX E (continued)

RAW SCORES OBTAINED BY SUBJECTS
ON H-P TEST

Subject	Pres. Score	Highest Task Passed	Total Errors	Error Index	Errors Failing Task: First Half	Errors Failing Task: Second Half
57	60	IV	40	2.1	24	16
58	63	IV	44	2.0	25	10
59	66	IV	54	2.2	23	19
60	60	IV	30	1.5	14	16
61	71	IV	49	1.6	22	13
62	63	IV	64	2.9	28	27
63	70	III	27	2.7	15	12
64	60	IV	43	2.2	27	16
65	61	IV	42	2.1	22	19
66	63	IV	60	2.6	32	24
67	60	IV	46	2.3	28	18
68	64	IV	47	2.0	19	21
69	66	IV	55	2.1	24	20
70	60	IV	32	1.6	17	15

APPENDIX F

APPENDIX F

RAW SCORES ACHIEVED ON THE STANFORD-BINET INTELLIGENCE SCALE

Subject	Age	MA	IQ	PS
24	27	2-8	114	75
27	28	2-10	110	72
29	30	2-9	106	73
30	32	2-11	109	77
36	36	3-9	118	65
37	37	3-6	105	67
38	37	3-11	118	74
42	40	4-6	135	67
45	41	4-4	118	70
48	45	4-5	108	67
53	48	5-1	124	68
55	52	5-9.2	130	70
56	54	5-6	125	63
58	55	5-3	109	64
59	56	4-8	100	66

APPENDIX F (continued)

RAW SCORES ACHIEVED ON THE STANFORD-BINET INTELLIGENCE SCALE

Subject	Age	MA	IQ	PS
60	57	4-8.4	98	61
64	58	5-4	108	60
65	59	5-5	110	61
a	28	2-11	121	78
b	30	2-3	90	71
c	32	3-4	125	71
d	36	3-8	122	84
e	39	3-11	121	64
f	40	4-2	119	68
g	42	4-9	133	70
h	49	4-10	116	79
i	50	5-3	124	83
j	55	5-10	125	65
k	59	5-2	119	69
l	59	5-6	112	63