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AUTHOR Gruen, Gerald E.
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ABSTRACT

Three studies compared learning and problem-solving performances of normal and familially-retarded children on tasks differing in complexity, and one study investigated motivational-personality differences. Main purpose of the first three studies was to investigate the controversy between developmental and defect theorists in mental retardation. Study 1 revealed no normal-retarded differences on conservation tasks of unequal difficulty and offered support for the developmental theorists. Studies 2 and 3 also revealed no normal-retarded differences on tasks of low complexity but differences did become apparent on more complex tasks. Normals were better able to eliminate irrelevant dimensions and respond to the relevant dimension in the learning tasks of Study 2 and showed more efficient use of information for generating problem-solving strategies in Study 3. Interpretation of findings was difficult because appropriate equating for socio-economic backgrounds of subjects was possible only in Study 1. Study 4 showed that the personality variables Achievement Need and Locus of Control are significant determiners of probability learning performance. It was concluded that findings had value for any theory of intellectual and motivational systems, but did not resolve the developmental-defect controversy. (Author/KW)

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Gerald E. Gruen
Department of Psychology
Purdue University
Lafayette, Indiana 47907

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SUMMARY

This report includes the results of three studies comparing the learning and problem-solving performances of normal and familially-retarded children on tasks that differed in complexity. In addition, it includes one study attempting to find motivational-personality differences in normal and retarded children. The main purpose of the first three studies was to investigate the controversy between developmental and defect theorists in the mental retardation area. A second purpose was to investigate the hypothesis that the performance of MA-matched normal and retarded children will differ in increasingly greater degrees as task complexity increases. Study 1 revealed no normal-retarded differences on conservation tasks of unequal difficulty and offered support for the developmental theorists. Studies 2 and 3 also revealed no normal-retarded differences on tasks of low complexity but differences did become apparent on tasks of greater complexity. The normal children were better able to eliminate irrelevant dimensions and respond to the relevant dimension in the learning tasks of Study 2 and showed more efficient use of information for generating problem-solving strategies in Study 3. However, interpretation of these findings was difficult because appropriate equating for socio-economic backgrounds of the two groups of subjects was possible only in Study 1. Study 4 demonstrated that the personality variables n Achievement and Locus of Control are significant determiners of probability learning performance. The role that these variables may have played in the normal-retarded differences found in Studies 2 and 3 was considered. It was concluded that these findings have value in themselves for any theory of the intellectual and motivational systems of children, but they do not resolve the developmental-defect controversy. In fact, it was concluded that this controversy is impossible to resolve experimentally.

Chapter I

INTRODUCTION AND GENERAL STATEMENT OF THE PROBLEM

A major controversy that has existed in the mental retardation area is that between general developmental theorists and defect theorists (see Zigler, 1967, for a comprehensive discussion of this issue). The general developmental theorists (Zigler, 1967; Cromwell, 1963) have argued that the familial[1] retardate's cognitive development differs from that of the normal only in respect to its rate and the upper limit achieved. Such a view generates the prediction that when rate of development is controlled, as is grossly done when groups of retardates and normals are matched on mental age (MA), there should be no difference in formal cognitive processes related to IQ. The defect theorists (Ellis, 1963; Goldstein, 1943; Kounin, 1941a, 1941b; Lewin, 1936; Luria, 1956; O'Connor & Hermelin, 1959; and Spitz, 1963) have argued that the retardate suffers from a specific psychological or cognitive defect over and above the slower general rate of cognitive development. This view generates the prediction that even when rate of cognitive development is controlled, as in the MA match paradigm, differences in conceptual functioning related to IQ should be found. On their face, the repeated findings of differences in performance between groups of normals and retardates matched on MA have lent credence to the defect position and have cast doubt on the general developmental formulation. The general developmental theorists' response to these frequently reported differences has been to point out that performance on any experimental task is not the inexorable product of the subject's cognitive structure alone, but is also influenced by a variety of emotional and motivational factors as well. The argument here is that differences in performance are more reasonably attributed to motivational differences which do not inhere in mental retardation but are rather the result of the particular histories of the typical retarded subject.

This controversy has recently been sharpened by the criticisms leveled at Zigler's developmental position by Weir (1967). Weir has attacked this position on both theoretical and empirical grounds. Weir agrees with Zigler that the primary difference between familially retarded and normal children is in rate of intellectual growth, but he believes that these differential rates should be reflected in short-term laboratory tasks. That is, the IQ should predict the rate at which a child will learn a laboratory task as well as the rate of his overall intellectual growth.

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[1]It is important to emphasize that these notions apply only to cultural-familial retardates and not to those retardates who show evidence of gross sensory or motor dysfunction.

He states that the developmental position should predict that normal and retarded children will perform differently on a short-term laboratory task "providing the task they are given is sufficiently complex to be sensitive to the abilities responsible for the differential rates of growth (Weir, 1967)." This latter point is an important one because Weir apparently believes that the studies Zigler (1967) cites to support his position are not sensitive to the abilities which determine the rate of intellectual growth. That is, the tasks used in Zigler's research are too simple and involve a minimum of learning and information processing. Thus, they cannot be used in any crucial test of the developmental position.

It is true that few studies have systematically compared normal and retarded children of the same MA on tasks of differing complexity. Most studies which have made such a comparison and found differences in the learning performances of normal and retarded children (Ellis, 1963; Goldstein, 1943; Kounin, 1941a, 1941b; Lewin, 1936; Luria, 1956; O'Connor & Hermelin, 1959; Spitz, 1963; and Zeaman & House, 1963) either used very severely retarded children (IQs below 50) and/or those with gross sensory or motor dysfunctions. Many of these studies also do not control for MA or fail to take account of important motivational variables (see Zigler, 1966, for a thorough review of the latter studies). Zigler makes it clear that this developmental approach is applicable only to moderately retarded children with no evidence of gross motor or sensory dysfunctions.

One study which did directly compare moderately retarded and normal children of the same MA on tasks of differing complexity used a limited range of complexity (Stevenson, 1960). Stevenson did two experiments, the first one using a series of seven two-choice discrimination tasks (simple tasks) and the second one using a three-choice pattern discrimination task (complex task). He found no significant differences between retarded and normal children on either type of task.

Another study (McManis, 1965) compared normal and familial retarded children on a number of serial verbal learning tasks in which word lists of different lengths were used. With this kind of task, word lists of greater length may be considered more complex. McManis found no significant differences between normal and retarded children in the number of errors made in learning these lists, regardless of the length of the word list. Both groups made significantly more middle serial position errors with longer lists, however. These findings agree with those of Giradeau and Ellis (1964).

In a related study, Prehm (1966) compared the associative learning abilities of retarded and normal children for both meaningful and nonmeaningful lists of paired associates. Each of these lists varied in task difficulty, difficulty being defined in terms of the mean number of trials to criterion in a pilot study using these lists. Prehm made no attempt to match subjects for chronological age (CA) or MA but did a covariance analysis with MA as the covariate. This analysis revealed an overall effect of task difficulty but no task difficulty X type of subject interaction. Thus, retardates did not perform at a significantly different level than normals as task difficulty increased.

Although this review is not exhaustive (other relevant studies will be reviewed in later chapters), it accurately reflects the flavor of the findings in this area. All of these studies taken together appear to offer support for the developmental hypothesis that familial retarded and normal children of the same MA do not differ in their learning performance on either simple or complex tasks. However, the investigators who set out to systematically compare the learning performances of familial retarded and normal children as a function of task complexity (Stevenson, 1960; McManis, 1965; and Prehm, 1966) emphasized tasks quite limited in their range of complexity. The complexity of the tasks they used may not have been enough to be sensitive to differential rates of learning between normals and retardates.

General Statement of the Problem

The major purpose of the first three studies included in this report was to investigate directly the controversy between developmental and defect theorists. At the same time, an attempt was made to evaluate Weir's hypothesis that the performance of normal and retarded children will differ in increasingly greater degrees as task complexity increases. In all three of these studies, normal and retarded children were matched for MA and presented with comparison tasks which were either problem-solving or learning tasks. In Study 1, Piagetian conservation tasks (Piaget, 1950) requiring logical operations were presented to the two groups. Study 2 employed more traditional laboratory learning tasks that differed in complexity as determined by the number of dimensions to which subjects had to respond. In Study 3 the problem-solving tasks presented lended themselves to an informational analysis and provided a precise way of manipulating task complexity. Thus, each of these studies investigated directly the similarities and differences in the cognitive functioning of normal and retarded children of the same MA.

A second purpose of this project was to relate motivational and personality differences between retarded and normal children to their performance on a laboratory learning task. Since developmental theorists (see Zigler, 1966) have emphasized that differences in the learning performances of these two groups are not due entirely to cognitive differences, an attempt was made in Study 4 to determine the specific nature of the motivational-personality characteristics of retarded children that deflate their performance on learning tasks.

Chapter II

STUDY 1: THE DEVELOPMENT OF CONSERVATION IN NORMAL AND FAMILIALLY-RETARDED CHILDREN

Statement of the Problem

Stevenson, Friedrichs, and Simpson (1970) have suggested recently that our understanding of the relation between intelligence and problem-solving remains at a primitive level despite current interest in this relationship. They cite the results of studies comparing subjects with different rates of intellectual development as being particularly inconsistent. For example, retarded children generally have been found to perform more poorly on learning and problem-solving tasks than their CA peers, but the results are inconsistent when they are compared to their MA peers, a more meaningful comparison.

This is important on a theoretical level because of the controversy in the mental retardation area between general developmental and defect theorists. As stated in the introduction, Zigler's "developmental position" generates the prediction that familially-retarded children should not differ in formal cognitive processes from their normal MA peers provided that emotional and motivational factors are reasonably controlled. Other theorists (Ellis, 1963; Goldstein, 1943; Lewin, 1936; Luria, 1956; O'Connor & Hermelin, 1959; and Spitz, 1963), whom Zigler calls "defect theorists," argue that the retardate suffers from a specific physiological or psychological defect over and above a generally slower rate of cognitive development.

Stevenson, Hale, Klein, and Miller (1968) and Stevenson et al. (1970) recently have found differences between MA-matched normal and retarded children in incidental learning, verbal memory, concept of probability, concept of conservation, and anagrams. Their retarded subjects performed more poorly than the normal subjects. These studies attempted to control for many of the kinds of emotional and motivational factors Zigler has shown to be important, such as institutionalization, supportive responses by adult experimenters, and general life histories. Furthermore, Weir (1967) recently has criticized Zigler's research for comparing retarded and normal children on tasks that are not "sufficiently complex to be sensitive to the abilities responsible for differential rates of growth." Weir suggests that the differences between retarded and normal children should be more evident as comparison tasks increase in difficulty.

It is possible, of course, that both developmental and defect theory are partially correct: on some tasks retarded and normal children of the same MA will differ and on others they will not. The question the present investigation tried to answer is whether retarded-normal differences do indeed become more evident as comparison tasks increase in difficulty.

This study investigated this issue with respect to certain of Piaget's (1950) conservation problems.

Thus far, the conservation literature in which comparisons have been made between normal and retarded children's performance does not help to clear up this issue. For example, Keasy and Charles (1967) and Brison and Bereiter (1967) reported no differences between normal and retarded children of the same MA in their ability to conserve substance. However, Stevenson et al. (1968) found that retarded children performed more poorly on volume conservation tasks than their MA peers. In addition, both Feigenbaum (1963) and Goldschmid (1967) have found the ability to conserve to be positively correlated with IQ.

Thus, the relationship of IQ, MA, and CA to the ability to conserve is unclear. In the present study, the authors attempted systematically to determine these relationships and to collect data that would offer further evidence to help resolve the controversy between developmental and defect theorists of mental retardation. Familially-retarded and normal children matched at three levels of MA (5, 7, and 9) were given three kinds of conservation tasks: conservation of number, conservation of quantity, and conservation of weight. The results of several previous investigations (Elkind, 1961; Goldschmid & Bentler, 1968; Piaget & Inhelder, 1947; Smedslund, 1961; and Uzgiris, 1964), considered together, indicate that these tasks increase in difficulty from number to quantity to weight. Given this experimental design, Weir's (1967) position, and that of the "defect theorists," would lead to the prediction that as the conservation tasks increase in difficulty (from number to weight), normal children will perform increasingly better than retarded children. Zigler's (1966) position, on the other hand, generates the prediction of no differences associated with IQ.

Method

Subjects

The subjects were 90 Caucasian children selected from classes in the Monroe County Community School System located in Bloomington, Indiana. All subjects were from upper-lower or lower-middle class socio-economic background. The experimental subjects consisted of three groups of familial mental retardates obtained from Special Education classes. These groups were defined by the MA of the subjects which were set at MA of 5, 7, and 9. Ten children were included in each group. A child was placed in a group if his MA fell within a range of ± 6 months of the MA levels specified. If a subject had been administered the Stanford-Binet Intelligence Scale, Form L-M, within the last year, the MA reported was pro-rated to the month that the present study was carried out. In cases where testing had not been done within the last year the child was retested using the Binet. In order to be included in an experimental group, subjects were required to have IQs within the 55-80 range. The records of all mentally retarded subjects were examined and no child with suspected organic pathology was used in the study.

Two types of control groups were included in the design of this study. The first consisted of three groups of ten subjects each matched for sex and MA with the experimental subjects described above. In order to complete the MA-5 group, some subjects had to be obtained from Head Start classes in the Bloomington area. The second set of control groups consisted of three groups matched with the experimental subjects by sex and CA. All subjects used in the control groups were administered the Slosson Intelligence Test. This test reportedly correlates (r = .90 - .97) with the Stanford-Binet Scale quite highly and both have a high loading on Spearman's "g" factor (Slosson, 1963). A subject was required to obtain an IQ within the 90-120 range in order to be included in a control group. The mean CA, MA, and IQ for each type of subject is given in Table 1.

TABLE 1

Mean CA, MA, and IQ for Each Type of Subject

Group	N	CA (in months)		MA (in months)		IQ	
		Mean	Range	Mean	Range	Mean	Range
Retarded							
MA-5	10	94.5	88-108	62.7	58-66	60.7	60-72
MA-7	10	123.3	104-151	80.1	78-90	67.0	62-75
MA-9	10	149.8	133-158	106.8	99-120	74.1	72-78
Normal							
MA-5	10	61.7	56-65	63.3	59-67	103.2	92-116
MA-7	10	74.0	68-80	81.6	78-90	110.4	103-118
MA-9	10	96.7	91-111	107.3	102-112	111.6	101-119
Normal							
CA_1	10	98.6	88-128	103.2	96-118	105.6	100-115
CA_2	10	122.9	102-153	129.9	102-146	105.5	92-118
CA_3	10	150.0	132-160	158.0	142-169	105.8	94-116

Materials

The materials required for each conservation task differed. The number conservation task was patterned after that employed by Rothenberg (1969). An 18 X 24 inch board painted half yellow and half blue with the two halves separated along the long axis by a narrow black line was used so that an array of poker chips on one side would be clearly distinguishable from one on the other.

For the continuous quantity (water) conservation task, two 400 ml (4 inches tall, 3-1/4 inches in diameter) beakers, one 350 ml (7 inches tall, 2-1/2 inches in diameter) beaker, and one 1100 ml (3 inches tall, 6 inches in diameter) beaker were employed. Thus, the displacements possible were from the two standard beakers to a taller, thinner beaker or from the standard beakers to a shorter, wider beaker.

The main apparatus for the weight conservation task was a pan scale 16 inches tall with a metal cross-bar 12 inches long. The vertical metal bar was mounted on a base 6 X 6 inches. A thumbscrew at the intersect of the two bars allowed the experimenter to increase or decrease the ease with which the cross-bar moved up or down on either end. Two black 5-1/2 inch in diameter pans hung from each end of the cross-bar by three 8-1/2 inch chains. For the pretraining task, designed to familiarize subjects in the use of the scale, four brass cylinders of equal size but different weights (1-1/2 inches tall, .75 inch in diameter) were required. For the test items themselves, Play-doh brand plasticine was employed to form the different shapes.

Procedure

Each subject was administered all of the conservation tasks individually in a private room at his school. Prior to the start of the testing procedure, the subject was shown a variety of toys and games and was told to select one that he liked best. He was then told that if he did well on the tasks, he could have the toy. The instructions given to each subject at the start of testing were as follows:

> "Now we are going to play some games. I will ask you to do some things for me and answer some questions about them. Some of them may be easy and some may be a little harder. Do the best you can on each of them. And remember, if you do a good job, you can have the ______ that you just picked."

The examiner was a Caucasian female graduate student working on her M.S. degree in Educational Psychology at Indiana University. She was trained in the administration of the conservation tasks and conducted all of the testing sessions. The _N_ was too small to allow for complete counterbalancing of the order in which the three tasks were presented. Thus, the order of administration of the three tasks was from easier to most difficult and was the same for all subjects: number, quantity, and weight.

Number Conservation Technique

All of the conservation task procedures used in this study were based on the technique developed by Rothenberg (1969). For the number conservation tasks, the board painted half blue and half yellow was used along with 14 red poker chips. Reference was made to "bunch" of chips on the "yellow" or "blue" side of the board. A warm-up item was administered in order to familiarize subjects with the procedure as well as to determine whether they understood the language ("same," "more") used in the questioning procedure. Only children who responded appropriately on the warm-up item were used in the actual study. Following each transformation, two consecutive questions were asked regardless of the response to the first. The questions were: (1) "Does this bunch (experimenter points to all the chips on the blue side) have the same number of chips as this bunch (experimenter points to all the chips on the yellow side)?" and (2) "Does one bunch have more chips?" Following Rothenberg (1969), children who answered "Yes" to Q_2 were asked: (a) "Which bunch?" and (b) "How can you tell?" Children who answered "Yes" to Q_1 and "No" to Q_2 were also asked, "How can you tell?" Inconsistent children who responded "No" to both Q_1 and Q_2 were asked Q_1 again. If they responded "Yes" this time, the experimenter moved on to the next transformation. If they responded "No," both (a) and (b) above were repeated.

The transformations used involved conservation of both equality and inequality. The equality conservation items involved the lateral displacement to the right of experimenter's row of chips (Item 1) and the collapsing of experimenter's row of chips into closer proximity than subject's row (Item 3). The inequality conservation items involved transforming experimenter's row of chips into a circular arrangement (Item 2) and the spacing out of experimenter's chips into a longer row (Item 4).

Quantity Conservation Technique

The same basic questioning procedure described above was used to administer the quantity conservation problem. Items 1 and 3 involved conservation of equivalence utilizing a height and width displacement, respectively. After the subject agreed that two standard beakers contained the same amount of water, the experimenter poured one of the two beakers into a third beaker that was taller and thinner (Item 1) or shorter and wider (Item 3). Items 2 and 4 involved conservation of inequivalence utilizing the same height and width displacements as those employed in Items 1 and 3. For subjects who did not conserve on Item 1, those who said the tall, thin beaker had more water than the standard beaker were presented with the following displacement on Item 2: the water from the standard beaker with less water was poured into the tall, thin beaker, causing it to rise to a greater height than the water level in the other standard beaker. Those who felt that the standard beaker had more water than the tall beaker on Item 1 were presented Item 2 in such a way that the beaker which actually had more water was poured into the tall beaker. This procedure was necessary because a small number of nonconservers thought the standard beaker had more water than the tall, thin beaker because it was wider. Similarly, on Item 4 the displacement made for nonconservers depended on their response to Item 3: if they thought the short, wide beaker had less water than the standard beaker, the standard beaker containing more water was poured into the short, wide beaker; if, on the other hand, they believed that the short, wide beaker contained more water than the standard beaker, the standard beaker with less water was poured into the short, wide beaker. Thus, the relevant perceptual cues conflicted with the tendency to conserve.

Weight Conservation Technique

The same basic questioning procedure was also used in the administration of the weight conservation problems. However, prior to the actual testing, subjects were given pretraining with a scale and weights. The object of the pretraining procedure was clarification of the concepts "weighs more" and "weighs the same" in the context of using the pan scale. The experimenter demonstrated to each child that the pan with the heavier weight went down when two objects were weighed and then asked the child to predict which pan would go down for a series of pairs of weights. Following this, the child was required to respond to the experimenter's queries concerning whether one object "weighed more" or "weighed the same" as another object. Only subjects who were able to respond correctly to these questions were included in the study. After a subject had completed the pretraining procedure, he was administered four problem tasks. Two of the tasks involved conservation of equivalence and two conservation of inequivalence. Two clay balls were initially presented, and after the subject agreed they had the same amount of clay, one was transformed into either a "hot dog" or a "donut." As in the water conservation task, the transformation made on the conservation of inequality items depended on the response made to the equivalence conservation items. For conservers, and nonconservers who on the equivalence items thought the "hot dog" and the "donut" had more clay than the ball, the ball with less clay was always transformed. For the small number of nonconservers who on the equivalence items thought the ball had more clay than the "hot dog" or "donut" the ball with more clay was always transformed.

Consistent with Rothenberg's (1969) procedure, children who answered "Yes" to Q_1 (essentially, are they the same number, amount, or weight) and "No" to Q_2 (essentially, does one have or weigh more) on the equivalence conservation tasks and "No" to Q_1 and "Yes" to Q_2 on the nonequivalence conservation tasks were considered conservers. In contrast to Rothenberg's procedure, however, children who responded inconsistently to Q_1 and Q_2 the first time, but then gave correct responses when the questions were repeated, were also considered conservers, even though they were "inconsistent conservers." Any other response combination was considered a nonconserving response. In addition, subjects were asked to explain their responses. These explanations were divided into three categories: (1) conserving explanation--those clearly indicating conservation; (2) nonconserving explanations--those clearly indicating nonconservation; and (3) ambiguous explanations--those not clearly indicating either conservation or nonconservation. The experimenter attempted to get subjects to elaborate and give further explanations of ambiguous explanations by interjecting some neutral statement such as "Tell me more" following each such response. If the response was still ambiguous, it was considered a nonconserving response.

Some general guidelines that were devised to permit a more objective categorizing of the explanations given by subjects are shown below. An attempt was made to divide conserving and nonconserving responses into several kinds of subcategories.

Conserving explanations. (1) All explanations which directly or indirectly refer to previous events in the same test item. (This category includes those explanations that merely refer to the fact that the number of chips [or the amount of water in the beakers, or the weight of the clay] were the same when we started and still are; and those explanations which more explicitly refer to the reversibility involved in the situation, e.g., with the water, "If we poured it back, it would be the same as before.").

(2) All explanations which contained an explicit reference to necessity. (This category includes those explanations which explicitly state that nothing has been added or taken away; and those explanations that, in some other fashion, contain an explicit reference to necessity, e.g., "It cannot become more.").

(3) All explanations which refer to the compensatory aspect of conservation. For example, in number conservation, all explanations that take into account the fact that the longer length of one row of chips is compensated for by bigger spaces between the chips in that row.

(4) Any explanations that are correct but do not fit into any of the above categories, e.g., "I know they are the same because I counted them."

Nonconserving explanations. (1) All explanations which directly or indirectly refer to observable, perceptual features of the present situation, e.g., with the clay balls, "I can see that it's bigger."

(2) Any other explanation that clearly shows that the child cannot conserve, e.g., "I don't know," "I forget," "My teacher told me so," etc.

Results

The explanations given by the subjects in response to the question "How can you tell?" were written down verbatim. Two judges then scored the explanations given as either conserving, nonconserving, or ambiguous. A total of 1,080 responses was involved, 360 for each conservation task. The two judges agreed on 1,037, or 96%, of their classifications. A correlation of .91 was obtained as an estimate of overall interjudge reliability. The separate interjudge reliability coefficients for the number, water, and weight conservation tasks were, respectively, .94, .86, and .90. Only 68 of the total 1,080 verbal explanations were classified as ambiguous responses. This figure is 6.3% of the total number of responses made. Ambiguous responses were considered nonconserving responses for purposes of analysis. Of the 702 total conservation judgments (without counting verbal explanations) made in all groups, only 28, or less than 4%, were "inconsistent conserving responses," i.e., correct judgments given after first giving an incorrect response to the first question. These responses were counted in the analyses as conservation responses.

Task and Group Comparison

The analyses used in this study were performed on two dependent variables: the number of correct (conserving) judgments and the number of correct judgments given in combination with an adequate logical explanation of conservation. There were four items for each of the three conservation tasks (number, quantity, and weight), and a subject got one point for each conserving response made. Thus, a subject could obtain a score ranging from 0 to 4 on each task and 0 to 12 for all three tasks together. Scores on the individual tasks were necessarily ordinal and non-parametric statistics were required for their analysis.

Table 2 presents the mean number of correct judgments made by subjects in each group regardless of their verbal explanations. Table 3 presents the mean number of correct judgments made in combination with a logical explanation of conservation by subjects in each group. Tables 2 and 3 summarize the data used in the analyses to be reported below.

TABLE 2

Mean Number of Conserving Judgments

	Task							
	Number		Quantity		Weight		Total	
Group	Normal	Retarded	Normal	Retarded	Normal	Retarded	Normal	Retarded
MA-5	1.7	1.4	0.5	0.6	0.4	0.1	2.6	2.1
MA-7	2.4	2.0	1.7	1.1	2.0	0.6	6.1	3.7
MA-9	3.9	3.4	3.8	3.6	3.5	3.2	11.2	10.2
CA_1	4.0		3.8		3.4		11.2	
CA_2	3.8		3.8		3.5		11.1	
CA_3	4.0		4.0		4.0		12.0	

TABLE 3

Mean Number of Conserving Judgments Made in Combination with Logical Explanations

	Task							
	Number		Quantity		Weight		Total	
Group	Normal	Retarded	Normal	Retarded	Normal	Retarded	Normal	Retarded
MA-5	0.4	0.5	0.1	0.1	0.3	0.0	0.8	0.6
MA-7	1.9	1.6	1.2	0.0	1.1	0.4	4.2	2.0
MA-9	3.4	3.0	2.8	2.7	1.7	1.9	7.9	7.6
CA_1	3.5		3.0		3.3		9.8	
CA_2	3.4		3.6		2.9		9.9	
CA_3	3.8		3.6		3.7		11.1	

Task Differences

The major purpose of this study was to compare normal and retarded children of the same MA on tasks having differing levels of difficulty. Thus, it was important to analyze the performance of all groups across tasks to determine whether they did indeed differ in difficulty. Friedman's two-way analysis of variance (Siegel, 1956) was used to determine differences across the three tasks, and when significant effects were found, the Wilcoxon matched-pairs signed-ranks test was used to determine which tasks differed from each other. The Ns for the latter tests often varied because of tied ranks. These analyses were performed within each MA and IQ group.

Analyses based on the criterion of conservation judgments alone. The Friedman analyses performed on the number of conservation responses made on each task revealed overall significant task effects at the MA-5 level ($\chi^2 = 12.25$, df = 2, $p < .01$) and the MA-7 level ($\chi^2 = 9.02$, df = 2, $p < .02$), but not at the MA-9 level ($p > .05$). The lack of significant task effects at the MA-9 level reflects the fact that subjects with an MA of 9 were making virtually all correct judgments (see Table 2). Further, the Wilcoxon test revealed that, at the MA-5 level, significantly more correct judgments were made on the number conservation task than either the quantity ($T = 9.0$, $N = 16$, $p < .01$) or the weight ($T = 11$, $N = 19$, $p < .01$) tasks. However, there was no significant difference between the quantity and weight conservation tasks ($p > .05$). A further breakdown of the MA-5 group revealed that this same relationship between tasks held up for the normal but not the retarded subjects. That is, within the MA-5 normal group more correct judgments were made on the number than quantity ($T = 2$, $N = 8$, $p < .02$) or weight ($T = 6$, $N = 10$, $p < .05$) tasks, but no significant differences between the quantity and weight tasks ($p > .05$) were found. However, for the retarded children at the MA-5 level, the difference between performance on the number and quantity tasks only approached significance ($T = 2.5$, $N = 7$, $.05 < p < .10$) and the difference between performance on the quantity and weight tasks was untestable because of the large number of tied ranks ($T = 0$, $N = 4$). As in the overall analysis, though, more correct judgments were made on the number than weight task ($T = 0$, $N = 9$, $p < .005$).

At the MA-7 level, further analyses revealed that the overall significant difference between tasks was largely due to the performance of the retarded children ($\chi^2 = 9.15$, df = 2, $p < .02$). No significant task effect was found for the normal children ($p > .05$). Within the retarded group at this level, number was significantly easier than quantity ($T = 16$, $N = 14$, $p < .02$) or weight ($T = 14$, $N = 13$, $p < .05$). However, quantity and weight did not differ significantly ($p > .05$).

In summary, when correct judgments alone were considered, performance was generally better on the number task than the quantity or weight tasks. This was true for every group except the MA-9 group and the normal children at the MA-7 level. The difference between performance on the quantity and weight tasks reached significance only once (in the retarded MA-5 group).

Analyses based on the criterion of conservation judgments given in combination with logical verbal explanations. The analyses performed on the combination of correct judgment and adequate explanation scores revealed overall significant task effects at the MA-7 level ($\chi^2 = 11.87$, 2 df, $p < .01$) and MA-9 level ($\chi^2 = 17.65$, 2 df, $p < .001$) but not at the MA-5 level ($p > .05$). It appears that the requirement of a logical verbal explanation of conservation responses was much too difficult for MA-5 level subjects (see Table 3). Further analyses revealed that at the MA-7 level more correct judgments and explanations were made on the number than quantity ($T = 26$, $N = 18$, $p < .01$) or weight ($T = 19$, $N = 17$, $p < .01$) tasks. However, the quantity and weight tasks did not differ significantly ($p > .05$). Normal subjects at the MA-7 level showed a trend toward making more correct judgments on the number than weight tasks ($T = 5$, $N = 8$, $.05 < p < .10$) but performances did not differ on other task comparisons. With retarded children, on the other hand, number was easier than both quantity ($T = 0$, $N = 9$, $p < .01$) and weight ($T = 5$, $N = 9$, $p < .05$). Again, however, the quantity and weight tasks did not differ significantly ($p > .05$).

At the MA-9 level, all three tasks differed significantly: more correct judgments and explanations were made on the number than the quantity ($T = 8$, $N = 11$, $p < .05$) or weight ($T = 0$, $N = 18$, $p < .01$) tasks; and quantity conservation was easier than weight conservation ($T = 15.5$, $N = 16$, $p < .01$). Normal children at this level did not differ in their performances on the number and quantity tasks ($p > .05$) but number conservation was significantly easier than weight conservation ($T = 0$, $N = 10$, $p < .01$) and quantity was significantly easier than weight ($T = 2.5$, $N = 8$, $p < .05$). Similarly, number was significantly easier for retarded children than weight conservation ($T = 0$, $N = 7$, $p < .02$) and quantity was easier than weight ($T = 0$, $N = 8$, $p < .01$). However, the difference between performance on the number and quantity tasks was untestable because of a large number of tied ranks.

In summary, when correct judgment plus logical verbal explanation was required of subjects, no significant task effect was found for MA-5 level subjects. However, at the MA-7 level a trend for more conservation responses on the number than weight tasks was found for normal children while retarded children performed at a significantly higher level on the number task than either the quantity or weight tasks. Finally, at the MA-9 level both normal and retarded children performed better on the number than weight task and on the quantity task than on the weight task.

Type of Subject Differences

Having shown that task differences did exist at the various levels (depending on which criterion for conservation was used at which MA level, however), the next step was to test the major hypothesis--namely, that the differences in the differences in the performance of normal and retarded children would increase as the tasks became more difficult. The data did not show this to be the case. Regardless of the criterion used, correct judgment alone or correct judgment plus logical verbal explanation, no differences which reached the .05 level of significance were found between normal and retarded children at any MA level or on any of the three conservation tasks. Mann-Whitney U-tests (Siegel, 1956) were used to test for differences. Tables 2 and 3 present the mean number of conservation responses given by normal and retarded children at each MA level and on each task.

Further analyses were performed on the verbal explanations given to determine whether the normal and retarded children differed in the kind of explanations they gave. Of the 539 conserving explanations given, only 14 were given at the MA-5 level--6 by retarded and 8 by normal children. Two (33%) of the explanations given by retarded children referred to Previous Events while four (67%) referred to Logical Necessity. For the normal MA-5 children three (37%) referred to Previous Events and five (63%) to Logical Necessity. The N for these groups are so small that no statistical tests were performed, but it is obvious that the type of conserving arguments given by retarded and normal children at the MA-5 level are very similar. The non-ambiguous verbal explanations of both retarded and normal non-conservers at this level virtually all referred to Perceptual Features for the number and water tasks. However, on the weight task, four children in each group made a cognitive association related to the type of transformation made--e.g., "Donuts are always light; ball must be heavier."

Sixty-two conserving explanations were given at the MA-7 level, 42 by the normal and 20 by the retarded children. Although a Mann-Whitney U-test (Siegel, 1956) did not reveal this difference to be significant ($U = 32$, $p > .05$), it is likely that this was due to the small N and the large number of tied ranks involved. Thirteen, or 65%, of the verbal explanations given by retarded children referred to Previous Events, while 30, or 71%, of the verbal explanations of normal children were in the same category. A chi-square analysis indicated that the two groups did not differ significantly ($\chi^2 = .07$, $df = 1$, $p > .05$) in the number of their verbal explanations that fell into this category. In other categories of verbal explanations for the MA-7 children, normal children made more arguments referring to Reversibility than retarded children (4 to 0) as well as more arguments referring to Logical Necessity (7 to 1). On the other hand, retarded children more often referred to Counting to justify their conserving responses on the number task than normal children did (6 to 1). These frequencies were so small that no statistical tests were performed on them. Again, the verbal explanations of both normal and retarded non-conservers primarily referred to Perceptual Features on all tasks (94% in both the normal and retarded groups). On the weight task, there were again a few responses based on cognitive associations related to the type of transformation made (donut, hot dog, etc.).

At the MA-9 level, 155 conserving explanations were given, 76 by retarded children and 79 by normal children. A Mann-Whitney U-test revealed that the two groups did not differ significantly ($U = 48.5$, $p > .05$). The proportion (and, in parentheses, actual number) of these responses that fell into each category of verbal explanations for normal and retarded children were, respectively: Reference to Previous Events--.09 and .11

(7 and 8); Reversibility--.29 and .36 (23 and 28); Logical Necessity--.13 and .07 (10 and 5); Reference to Add/Subtract--.10 and .07 (8 and 5); Compensation--.28 and .25 (22 and 19); and Counting (for the number task)--.11 and .14 (9 and 11). The only categories with large enough frequencies to meaningfully perform statistical analyses on were the Reversibility and Compensation categories. Chi-square analyses revealed no differences between normal and retarded children in either of these categories of response ($\chi^2 = .32$, df = 1, $p > .05$; and $\chi^2 = .01$, df = 1, $p > .05$, respectively). The verbal explanations of non-conservers at the MA-9 level all referred to Perceptual Features to justify their responses or gave ambiguous (non-classifiable) responses.

Generally, then, the retarded and normal children differed very little in the kinds of verbal explanations they gave to justify their responses on the conservation tasks. Only at the MA-7 level were differences noted, and these were in the Reversibility, Logical Necessity, and Counting categories. Unfortunately, the total number of logical verbal explanations given in those categories was so small as to make it difficult to perform statistical tests on them.

Mental Age Effects

The mean number of correct judgments made by MA-9, MA-7, and MA-5 children were 10.7, 4.9, and 2.4, respectively, across all tasks. A Kruskal-Wallis one-way analysis of variance (Siegel, 1956) revealed that the means were significantly different ($H = 21.09$, df = 2, $p < .01$). Further Mann-Whitney U-tests revealed that the MA-9 subjects performed at a significantly higher level than the MA-7 ($Z = -4.96$, $p < .01$) or MA-5 ($Z = 5.43$, $p < .01$) subjects. The MA-7 subjects also did better than the MA-5 level subjects ($Z = 2.26$, $p = .012$).

The mean number of correct judgment plus explanation responses for MA-9, MA-7, and MA-5 subjects was 7.85, 3.1, and 0.7, respectively, across all tasks. A Kruskal-Wallis one-way analysis of variance revealed that these means differed significantly ($H = 18.74$, df = 2, $p < .01$). Further Mann-Whitney U-tests revealed that MA-9 subjects performed at a significantly higher level than MA-7 ($Z = 3.89$, $p < .01$) or MA-5 ($Z = 5.28$, $p < .01$) subjects. In addition, MA-7 subjects did better than MA-5 subjects ($Z = 4.05$, $p < .01$).

Chronological Age Effects

In addition to comparing retarded children with normal children of the same MA, retarded children were also compared to normal children of the same CA. Table 2 indicates that when correct judgment alone is the criterion for conservation, the performance of the CA groups was nearly perfect. A Mann-Whitney U-test (with $n_1 = n_2 = 10$) revealed that group CA_1 performed at a significantly higher level ($U = 0$, $p < .02$) than the MA-5 retarded children with whom they were matched. Similarly, the CA_2 group of normal children performed at a higher level ($U = 0$, $p < .02$)

than the retarded children with whom they were matched, the MA-7 retarded group. However, no difference was found between the CA_3 group and the MA-9 retarded children ($U = 20$, $p > .05$) because both groups made nearly all correct judgments.

Table 3 shows that the normal children matched for CA with the retarded children also did well when the criterion for conservation was considered to be a conserving judgment in combination with a logical verbal explanation. Group CA_1 did significantly better than the MA-5 retarded group ($U = 0$, $p < .02$); group CA_2 did significantly better than the MA-7 retarded group ($U = 0$, $p < .02$); and group CA_3 performed at a higher level than the MA-9 retarded children ($U = 8$, $p < .02$). Again, for each of these analyses, $n_1 = n_2 = 10$.

Sex Differences

The effect of sex of subjects was rather difficult to assess in this study due to the fact that there were uneven splits of males and females in three groups. The MA-9 retarded group, the MA-9 normal group, and the CA_3 group each consisted of nine males and one female. Thus, no analysis for sex differences could be carried out for these groups. The remaining groups, however, had approximately even splits of males and females (either a 5-5 or a 4-6 split). Analyses were performed on these groups. No sex differences were found ($p > .05$ in all cases).

Conservation of Equality versus Conservation of Inequality

On some of the tasks, conservation of inequality appeared to be easier than conservation of equality. Since each conservation task consisted of two equality and two inequality conservation items, the sign test (Siegel, 1956) was used to determine whether this trend was significant.

When correct judgment alone was used as the criterion, the sign test revealed that conservation of equality was significantly more difficult than the conservation of inequality for the number ($Z = 2.87$, $N = 31$, $p < .01$) and quantity ($X = 2$, $N = 25$, $p < .01$) tasks, but not the weight task ($X = 5$, $N = 15$, $p > .05$). When correct judgment plus logical verbal explanation was used as the criterion, conservation of equality was significantly more difficult than conservation of inequality only on the weight task ($X = 5$, $N = 21$, $p = .026$). It was never true on any of the tasks that conservation of equality was easier than conservation of inequality.

Discussion

The hypothesis that differences in the performance of retarded and normal children would increase as task difficulty increased (Weir, 1967) was clearly not supported by this investigation. No differences related to IQ in performance on any of the three conservation tasks were found.

Rather, mental age was clearly the most reliable predictor of performance. In general, this finding is consistent with Zigler's developmental position with respect to mental retardation. It is also consistent with the work of Brison and Bereiter (1967) and Keasy and Charles (1967).

However, it is not consistent with "defect theory" or the findings of Goldschmid (1967), Feigenbaum (1963), or Stevenson et al. (1968), who reported a relationship between IQ and conservation. Although the reason for this discrepancy is not clear, it should be noted that two of the latter investigators used different populations than the ones employed in the present study. Goldschmid compared normal and emotionally disturbed children while Feigenbaum used a group of children whose IQs were above average. In fact, the only relevance of these studies to the present one is their finding of a relationship between IQ and conservation. The differences between our findings and those of Stevenson et al. (1968) could have occurred for a number of reasons: first, they used a volume conservation task, a task generally found to be more difficult than the tasks employed in this study (see Uzgiris, 1964); secondly, their subjects were all near the upper MA range used in the present study, MA-9, or higher; thirdly, they used a group testing procedure; and, fourthly, the instructions and procedures for all their tasks were on film and subjects responded in test booklets. Any, or all, of these procedural differences could account for the discrepancy between our findings and those of Stevenson et al. (1968).

It should be noted, of course, that the use of a small N in each group in the present study works against the detection of small differences between groups. The relative differences between the retarded and normal children at the MA-7 level, for example, might have reached statistical significance if a larger N had been employed. Similarly, the analysis of verbal explanations at the MA-7 level suggested that the normal children relied more heavily on arguments based on reversibility and logical necessity than retarded children while the latter group resorted to counting on the number conservation tasks more often than did the normal children. However, these data are based on very few observations, and the similarities in responses given by normal and retarded children are much more striking than their differences, particularly at the MA-5 and MA-9 levels. It is interesting that the only differences between groups that are even suggested occur at the MA-7 level. This is most likely because this is where the transition from pre-operational to concrete-operational thinking is occurring most rapidly. The data in Tables 2 and 3 indicate that the normal children advance through this transition period more rapidly than the retarded children.

One error in the design of this study should also be noted. Table 1 reveals that MA and IQ were not entirely orthogonal in the present study. Since the criterion for inclusion in the mental retardation group was simply to have an IQ below 80, no attempt was made to equate the different MA groups for IQ. Table 1 reveals that children with higher MAs also had higher IQs in both subject groups. However, it is doubtful that this error is sufficient to account for the difference in our results and those of Stevenson et al. The lack of statistical differences in performance between normal and retarded children within each MA level still argues strongly that MA accounts for virtually all the variance in performance on the conservation tasks.

The general finding that number conservation was relatively easier than conserving continuous quantity, and that the latter was easier than conservation of weight, is consistent with previous findings (e.g., Goldschmid & Bentler, 1968; Uzgiris, 1964). However, there were some puzzling divergences from this general trend. For example, no significant task effects were found for the normal children of MA-7 when either criterion was used. However, significant task effects were found for the MA-7 retarded children. Further, only the retarded group performed better on the quantity than weight task at the other MA levels. This illustrates a general finding in this study that performance differences on the three tasks were more often significant for retarded than for normal children. McManis (1969) has suggested that there is a transitional period (MA of 7-10) in which the various concrete operations are obtained and that retarded children progress through this period more slowly than do normal children. If this is true, it would be expected that the performance of normal children on various conservation tasks would vary less from task to task than that of retarded children. This also suggests that retarded children may be ideal subjects for investigating the transition process from pre-operational to concrete-operational thinking.

The criterion employed to define conservation made considerable difference. Task differences were greatest at the MA-5 level when the criterion of correct judgment alone was employed while they were greatest at the MA-9 level when a logical, verbal reason was required in addition to a correct judgment. It is interesting that the same developmental trend for obtaining the various conservations was evident regardless of which criterion was used. This suggests that the same, or at least very similar, process is tapped using either criterion and that the more stringent criterion reflects a more highly developed and stable version of the same process that is tapped by the less stringent criterion.

In terms of method, Rothenberg's (1969) general questioning procedure has much to recommend it. It allows one to ascertain whether the subject understands the language employed in the questioning (see also Gruen, 1966, and Griffiths, Shantz, and Sigel, 1967), and it is economical in terms of efficiency. The finding in the present study that conservation of inequality is relatively easier than conservation of equality confirms Rothenberg's (1969) similar finding and helps to emphasize the need to use both kinds of items in assessing conservation. Such a procedure helps to control for the possibility of response sets such as saying "yes" or "no" to every item. One minor problem with Rothenberg's procedure is that question repetition may tend to cause children to change their original response simply because the examiner's repeating the question suggests that their first response was incorrect. It is possible that the child perceives the repetition as a cue to change his response. Further work should be done to determine if this is a significant factor affecting children's performance on conservation tasks.

Chapter III

STUDY 2: VISUAL DISCRIMINATION LEARNING IN FAMILIALLY-RETARDED AND NORMAL CHILDREN

Statement of the Problem

This study is a continuation of the attempt to offer experimental findings relevant to the controversy between developmental and defect theorists in the area of mental retardation. It is also a further attempt to investigate Weir's (1967) hypothesis that differences in the learning performance of retarded and normal children will increase as task complexity increases. This study differs from Study 1 in that discrimination learning tasks were employed as the criterion comparison tasks.

The research literature on discrimination learning of normals and retarded children reaches voluminous proportions, but relatively few studies undertake a comparison of normals and retardates matched for MA, a paradigm dictated by the developmental hypothesis (Zigler, 1966). Among these studies there is indeed a heavy emphasis on relatively easy discriminations, and only two studies vary stimulus complexity (thereby presumably varying task difficulty) within the experimental design. Before passing on to a review of these and other studies, it is necessary to define the term "stimulus complexity."

A comparison across studies suggests that two modes of varying stimulus complexity typically have been employed. These are: (1) varying the number of stimuli from which S must choose on any one trial, and (2) varying the number of dimensions of a stimulus configuration, from which the subject must choose the relevant dimension across trials. It is assumed in these studies that the more stimuli or dimensions in the stimulus complex, the more difficult the task. For example, a problem where the subject must choose from among four simultaneously-presented stimuli that differ along one dimension on a given trial is more difficult than one requiring a choice between two simultaneously-presented stimuli. Similarly, the choice between two stimuli is more difficult when these vary along several dimensions (e.g., form, color, and size) than when they vary along only one dimension.

In the present study the latter method of varying stimulus complexity was employed. Assuming a relatively simple problem with only two dichotomized dimensions (e.g., form and color, dichotomized as circle/square and red/blue), one can present the subject with a choice between a blue circle and a red square on trial one and a choice between a red circle and a blue square on trial two. If blue is the reinforced cue in each of these stimulus configurations, then color becomes the relevant dimension to which the subject must attend and form the irrelevant dimension. Adding another irrelevant dimension to this problem (e.g., size, dichotomized as small/large) and varying it with each of the above stimulus configurations (e.g., small blue circle vs. large red square on trial one, small red circle vs. large blue square on trial two, etc.), we have doubled the number of stimulus configurations and increased the number of cues to which the subject might respond, and thereby presumably increased the difficulty of the discrimination problem.

If, as in the problem described above, the choice is always between two simultaneously presented stimuli, then position (whether left/right or top/bottom) is necessarily also a "dimension" of the stimulus complex although it is usually designated as irrelevant. Evans (1968) uses the term "varying irrelevant dimension," and uses the notation 2VID to designate a problem with two varying irrelevant dimensions. This notation will be used in the following review.

The studies under review generally favor the conclusion that there is no difference in original learning between normals and retardates matched for MA. Two studies, however, report a difference. Rudel (1959) found slower learning by retardates on a two-choice size discrimination task with position as the VID. In a relatively more complex study, House and Zeaman (1958) found slower learning by retardates at the MA-4 level but no difference at the MA-5 level. They employed a relatively more complex two-choice form or color discrimination with position and form or color as the VIDs.

Other studies found no difference in original learning for the two groups. O'Connor and Hermelin (1959) and Balla and Zigler (1964, Exp. I) both employed a relatively simple two-choice size discrimination with position the VID. A three-choice size discrimination with position irrelevant was employed in Experiment II of the Balla and Zigler study, as well as by Stevenson and Zigler (1957), Kass and Stevenson (1961), and Experiment II of the Stevenson (1960) study. None found a significant difference in original learning between normals and retardates matched for MA.

Other studies with position as the only VID are those by Plenderleith (1956), Stevenson (1960), and Miller et al. (1968). Plenderleith and Stevenson (Exp. I) used a two-choice object discrimination while Miller et al. employed a four-choice object discrimination. None found a difference between normals and retardates.

Somewhat more complex studies were undertaken by Sanders et al. (1965), Klugh and Janssen (1966), and Achenbach and Zigler (1968). Sanders et al. used a two-choice form or color discrimination with position and color or form as the VIDs; no difference in original learning was found for the two groups. Klugh and Janssen used a more complex two-choice form discrimination with three VIDs: color, size, and position. Achenbach and Zigler employed a three-choice relative size discrimination with absolute size, color, and position the VIDs. These last two studies, the most complex in the present review, fail to demonstrate a significant difference between normals and retardates.

Several conclusions emerge from the present review. First, it is clear that most studies conclude that there is no difference in original discrimination learning between groups of MA-matched normals and retardates.

Twelve studies reach this conclusion, while only two find a difference.

Secondly, most studies rely heavily on size discriminations and employ position as the only varying irrelevant dimension. Eight of the 14 studies designate size as the relevant dimension, and 10 vary position as the only irrelevant dimension. This second conclusion makes the first less tenable; it would be desirable to determine whether a difference exists in learning for a wider range of concepts, and to test for a possible relation between type of relevant concept and task difficulty as well as a possible interaction between type of subject and type of concept.

The third conclusion is that while the studies as a whole reflect a range of stimulus complexity, it is desirable to vary stimulus complexity within an experimental design; differences in the type of subjects, stimulus dimensions, reinforcement, and mode of stimulus presentation make a comparison across studies on the complexity variable alone unsound. Only two of the above studies make such a within design comparison. Stevenson (1960) and Balla and Zigler (1964) both compared groups on a two-choice and a three-choice discrimination with position the only VID. While they found no difference between groups on either task, the tasks themselves represented a very limited degree of stimulus complexity. Balla and Zigler also indicated that this mode of varying stimulus complexity, variation in the number of stimuli from which a subject must choose, was not an adequate mode of varying task difficulty:

> "...none of the groups evidenced any significantly greater difficulty in learning the three-choice than the two-choice original learning problem. It would appear that the solution to both problems was mediated by the concept that the reward was always under the same sized stimulus, making the absolute number of stimuli of minor import (p. 663)."

The present study was an attempt to overcome some of these shortcomings. In the present study the author (1) varied stimulus complexity by varying the number of irrelevant stimulus dimensions, (2) employed three concepts--form, color, and size--as relevant and irrelevant dimensions, and (3) compared normals and retardates at two levels of complexity--2VID and 3VID. The stimulus configurations in the present study are those employed in a study by Osler and Kofsky (1965) with normal children. The concepts or stimulus dimensions used were form, color, and size.

Method

Subjects

Subjects were 36 retarded children and 36 normal children matched individually, within 3 months, for MA. Half the retarded subjects were residents of Plymouth State Home and Training School, an institution for the retarded, and the other half students in Special Education classes at Jamieson Elementary School in Detroit. The normal subjects matched with the Special Education subjects were also students at Jamieson, and the normal subjects matched with the institutionalized retardates were students at Klondike Elementary School in Indiana. Subjects were not selected for sex; 26 of the retarded subjects and 22 of the normal subjects were boys.

Retardates evidencing gross sensory or motor dysfunction were not selected for the experimental tasks. The retardation of the Special Education children was not classified but was presumed to be of cultural-familial origin. Of the institutionalized retardates, 14 were classified by the institution as mentally retarded "due to uncertain cause with the functional reaction alone manifest," 3 due to "unknown or uncertain cause with the structural reactions manifest," and one of cultural-familial origin.

The mean IQ of the institutionalized subjects, as measured by the Slosson Intelligence Test (1963), was 41.6. The mean MA was 6-8 with a range of 5-0 to 9-10. The CA of this group ranged from 10-10 to 22-7 with a mean of 17-4. The Special Education subjects had a mean IQ of 69.5, a mean MA of 6-6 with a range between 5-0 and 8-4, and a mean CA of 9-5 with a range between 7-3 and 11-4. The normal subjects had a mean IQ of 107.6, a mean MA of 6-9 ranging between 5-2 and 9-10, and a mean CA of 6-5 ranging between 5-6 and 9-0.

Apparatus and Stimulus Configurations

The stimulus configurations were presented with a standard 35 mm slide projector and viewing screen measuring approximately 2' X 2'. Subject and experimenter sat side by side at a table with the screen in easy reach of the subject, who indicated his response by touching one of the two stimulus configurations projected on the screen.

Each slide consisted of two stimulus configurations, one to subject's left, one to his right. Each problem set employed eight slides; half showed the reinforced cue on the left, half on the right. The order of the slides, the same for each subject, was determined at random and was such that the reinforced cue appeared in the following positions: RLRLLRRL.

For both the 2VID and 3VID discriminations three relevant concepts were tested (form, color, and size), resulting in six distinct problems (2F, 2C, 2S; 3F, 3C, and 3S). The reinforced cue along each of these dimensions was arbitrarily chosen and were, respectively, circle, red, and larger (one inch). The nonreinforced cues were square, blue, and smaller (5/8 inch). The position dimension was not tested for and remained an irrelevant dimension in all six problems.

The 2VID problem where form was designated the relevant dimension (2F) was presented with color and position as the VIDs and size remaining constant over trials. The 2C problem was presented with form and position the VIDs with size remaining constant, while the 2S problem employed color and position as the VIDs with form (square) remaining constant over trials. The 3VID problems were presented with the relevant and three irrelevant dimensions varied over trials. Table 4 illustrates the stimulus configurations and order of presentation for each of the six problems.

TABLE 4

Stimulus Configurations in Order of Presentation

Problem	Stimulus Configurations
2VID-Form	RC/BSq, RSq/BC, RC/BSq, RSq/BC BSq/RC, BC/RSq, RC/BSq, RSq/BC
2VID-Color	RC/BSq, BC/RSq, RC/BSq, BC/RSq BC/RSq, RC/BSq, RC/BSq, BC/RSq
2VID-Size	LB/SmR, SmB/LR, LB/SmR, SmB/LR SmB/LR, LB/SmR, LB/SmR, SmB/LR
3VID-Form	LBC/SmRSq, LRSq/SmBC, LBC/SmRSq, LRSq/SmRC LBSq/SmRC, LRC/SmBSq, LRC/SmBSq, LRSq/SmRC
3VID-Color	LRC/SmBSq, LBC/SmRSq, SmRC/LBSq, SmBC/LRSq LBC/SmRSq, LRC/SmBSq, SmRC/LBSq, SmBC/LRSq
3VID-Size	LBC/SmRSq, SmBC/LRSq, LBC/SmRSq, SmBC/LRSq SmRC/LBSq, LRC/SmBSq, LRC/SmBSq, SmRC/LBSq

Note: The order of presentation reads from left to right. R = red, B = blue, C = circle, Sq = square, Sm = small, and L = large. The first entry represents a slide consisting of two stimulus configurations, a red circle on the left and a blue square on the right.

Procedure

The procedure consisted of three parts: intellectual assessment, pretesting/pretraining, and concept attainment. Retarded subjects were given the Slosson Intelligence Test (1963) during the first phase. When MAs had been determined for all subjects in one group of retardates (the procedure being conducted separately for the institutionalized and Special Education subjects), subjects were ranked from low to high by MA. The first subject was then assigned a 2VID problem, the second a 3VID problem, and so on. Subjects in both the 2VID and 3VID problem groups were then randomly assigned to one of the three relevant dimensions: form, color, or size. Each subject, therefore, was assigned to only one of the six experimental problems.

Normal children were given the Slosson Intelligence Test and selected as subjects if their MAs were within 3 months of the MA of a subject in the retarded group. If a normal child could be matched with more than one retarded subject, he was matched with that subject closest in MA or, in the case of conflict with more than one retarded subject of the same or equally distant MA, with that subject appearing earlier on the rank ordered list of MAs. The normal subject was then assigned the same experimental problem as the retarded subject.

The second phase consisted of a combination of pretesting and pretraining. All subjects were presented with a card representing two stimulus configurations, a small red circle and a large blue square. The subject was required to point to one of the two configurations in response to the experimenter's questions. The questions were asked in the same order for each subject and were, in order, as follows: "Which one is bigger?...red? ...smaller?...square?...blue?...round?" The procedure served as a pretest in that it determined whether subjects could discriminate between the forms, colors, and sizes used in the concept formation task, and as a pretraining task in both the multidimensional nature of each configuration and the motor response of pointing to the correct configuration. No subject responded incorrectly, or failed to respond, to any of the six questions.

During the third phase, the concept formation task, the subject was required to abstract a particular form, color, or size as the relevant cue in responding to the configurations projected on the screen. The subject was instructed as follows:

> "I am going to show you some pictures. You see, you can see two pictures at the same time (E demonstrates with the first slide). One of the two pictures will give you a penny. See if you can guess which picture will give you the penny. Point to the picture you think will give you a penny and see if you can figure out how to get a penny every time you point to a picture."

The experimenter then presented the next slide, the first having been used in the demonstration and reinforced or not, depending upon the subject's response. After each correct response the experimenter said "good" and gave the subject a penny. After each incorrect response the experimenter said "no." In either case, the experimenter immediately presented the next slide. Responses were elicited until the subject made ten consecutive correct responses or was given a maximum of 120 trials. Those subjects reaching criterion were asked "How did you know which one would give you a penny?" to ascertain whether the subject could verbalize the solution. Subjects verbalizing the correct cue (circle, red, or larger) were scored as having provided the correct verbal solution.

Results

Trials-to-Criterion Analyses

Table 5 summarizes the 2 X 2 X 3 analysis of variance on the number of trials to criterion (10 consecutive correct responses) for normals and retardates, with two levels of complexity and three concepts. This analysis revealed no significant effect of groups, although both the complexity ($F = 8.32$, $df = 1,60$, $p < .01$) and concepts ($F = 12.09$, $df = 2,60$, $p < .01$) factors are highly significant. The significant complexity effect indicates that subjects took more trials to reach criterion in the 3VID than the 2VID problems (means equal 49.97 and 27.11, respectively). A Newman-Keuls test on the concept factor showed that color is significantly more difficult than size ($q = 6.87$, $df = 3,60$, $p < .01$) and more difficult than form ($q = 4.34$, $df = 2,60$, $p < .01$). There is also a nonsignificant trend showing form more difficult than size ($q = 2.52$, $df = 2,60$, $.10 > p > .05$). The group by complexity interaction shows a nonsignificant trend toward slower learning for the retarded group on the 3VID problems ($F = 3.18$, $df = 1,60$, $.10 > p > .05$). Table 6 shows the mean trials to criterion for each group on each problem.

TABLE 5

Groups X Concepts X Complexity Analysis of Variance: Normal vs. Retarded Subjects

Source	df	MS	F
Groups (A)	1	754.01	
Concepts (B)	2	13660.66	12.09**
Complexity (C)	1	9407.35	8.32**
A X B	2	1254.39	
A X C	1	3598.35	3.18*
B X C	2	1515.05	
A X B X C	2	572.38	
Within Cell	60	1129.85	

* $.10 > p > .05$
** $p < .01$

TABLE 6

Mean Trials to Criterion for Each Type of Subject

	2VID			3VID		
	Form	Color	Size	Form	Color	Size
Retardates	12.83	43.5	13.5	76.16	76.33	28.33
Inst.	11.33	52.0	10.66	46.66	56.33	26.33
Sp. Ed.	14.33	35.0	16.33	105.66	96.33	30.33
Normals	18.0	60.5	14.33	30.5	76.5	12.0
Total	15.41	52.0	13.91	53.33	76.41	20.16

In this table it can be seen that the institutionalized retardates learn more rapidly than the Special Education retardates. Table 7 summarizes a 2 X 3 X 2 analysis of variance performed on the number of trials to criterion where the two groups compared are the institutionalized and Special Education retardates. The main effect for groups was again not significant ($F = 2.23$, $df = 1,24$, $p > .10$) although the group by complexity interaction approaches significance ($F = 3.09$, $df = 1,24$, $.10 > p > .05$). Since it is unreasonable to attribute the more rapid learning to institutionalization or a lower IQ, the difference is probably due to the higher MA and/or CA of the institutionalized group (the two retarded groups not having been matched for MA).

TABLE 7

Groups X Concepts X Complexity Analysis of Variance: Institutionalized vs. Special Education Retardates

Source	df	MS	F
Groups (A)	1	2240.45	2.23
Concepts (B)	2	4629.69	
Complexity (C)	1	12321.0	
A X B	2	554.69	
A X C	1	3098.78	3.09*
B X C	2	1803.25	
A X B X C	2	846.02	
Within Cell	24	1000.46	
Total	36		

* $.10 > p > .05$

Only five retardates and six normals failed to reach criterion in this study. Of those subjects reaching criterion, 13 retarded and 7 normal subjects were unable to provide the verbal solution to the problems. This difference between retarded and normal subjects did not reach significance ($\chi^2 = 2.39$, $df = 1$, $p > .10$).

Other Chi-square tests support the conclusion drawn from Tables 5 and 6 that the 3VID problems were more difficult than 2VID problems. Nine subjects failed to reach criterion on the 3VID problems compared to only two on the 2VID problems. A Chi-square test showed this difference to be significant ($\chi^2 = 5.25$, $df = 1$, $p < .025$).

Number of Correct Responses Analyses

Table 8 summarizes a 2 X 6 analysis of variance (repeated measures) comparing the number of correct responses on tasks at the two levels of complexity across trials. In this analysis it was assumed that subjects who reached criterion would have made correct responses on all trials following the attainment of the criterion. The complexity main effect was significant ($F = 4.93$, $df = 1,70$, $p < .05$) as was trials ($F = 2.91$, $df = 5,350$, $p < .05$). The significant complexity effect was due to more correct responses on the 2VID problems than the 3VID problems (mean number of correct responses across subjects and blocks being 18.89 and 16.98, respectively). The significant trials effect simply reflects the fact that the number of correct responses increased over trials although this reflects more the fact that more subjects reached criterion than that the individual subjects showed an increase in correct responses over trials.

TABLE 8

Complexity X Trials Analysis of Variance

Source	df	MS	F
Between Subjects	71	314.24	
Complexity (A)	1	216.33	4.93*
Ss within groups	70	52.91	
Within Subjects	360	228.58	
Trials (B)	5	165.74	2.91*
A X B	5	6.02	
B X Ss within groups	350	56.82	

* $p < .05$

Table 9 summarizes a 3 X 6 analysis of variance for concepts and trials. The concept main effect is significant ($F = 12.06$, $df = 2,69$, $p < .01$) as is the effect of trials ($F = 2.74$, $df = 5,345$, $p < .05$). These results support the earlier conclusion that color is more difficult than form, and form more difficult than size.

TABLE 9

Concepts X Trials Analysis of Variance

Source	df	MS	F
Between Subjects	71	650.13	
Concepts (A)	2	600.36	12.06**
Ss within groups	69	49.77	
Within Subjects	360	232.65	
Trials (B)	5	157.68	2.74*
A X B	10	17.63	
B X Ss within groups	345	57.34	

* $p < .05$; ** $p < .01$

The Relationship of IQ, MA, and CA to Learning

Table 10 provides correlations of IQ, MA, and CA with trials to criterion for each of four groups. An r of .40 (df = 16) is needed for significance at the .05 level; inspection of the table will show that no r reaches this level of significance. Eight of the 12 correlations are in the predicted direction (negative, since trials to criterion should decrease with an increase in months of MA and CA and points in IQ). The relatively low correlations are probably best explained by the small variability in trials to criterion; 57% of the subjects reached criterion within the first 20 trials, and 71% within the first 40 trials. This suggests that the problems were relatively simple for the children in this sample and a ceiling effect markedly reduced the range of performance. It is possible that the pretraining in the multidimensional nature of the configurations served to reduce the difficulty of the tasks and the effects of mental age and intelligence on solution; the child with a lower MA or IQ may have been at a greater disadvantage without this pretraining.

TABLE 10

Correlation of CA, IQ, and MA With Trials to Criterion for Four Groups

	CA	IQ	MA
Retarded Subjects			
2VID	.08	-.16	-.18
3VID	.04	.14	.19
Normal Subjects			
2VID	-.13	-.20	-.24
3VID	-.05	-.35	-.27

Sex Effects

Sex was not a controlled variable in the present study; subjects were matched and assigned to experimental problems irrespective of sex. A t-test comparing the performance (trials to criterion) of boys and girls indicated, however, that sex was a significant determiner of learning performance. The girls took significantly fewer trials to reach criterion than the boys on the 2VID problems ($t' = 1.95$, $df = 34$, $p < .05$) and learned more rapidly on the 3VID problems, although not at a significant level ($t' = 1.07$, $df = 34$, $p < .10$).

Discussion

One hypothesis investigated in this study was whether differences in the learning performances of normal and retarded children would increase as task complexity increased, the retarded children learning more slowly than normal children on the 3VID problems but not the 2VID problems. The results indicate only a nonsignificant trend toward slower learning of the 3VID problems for retardates when compared to normals and no differences between these groups on the 2VID problems. The pretraining in the multidimensional nature of the stimulus configuration may have, as discussed earlier, somewhat reduced the effects of intelligence on learning. Future studies might manipulate pretraining to assess the effects on learning for both normals and retardates. It would also be of interest to know whether the trend toward slower learning by retardates would continue on 4VID problems with, for instance, number as the fifth dimension. The child on a given trial would then make a choice between, let's say, two small red circles on the left and three large blue squares on the right. Problems at this level of difficulty might provide results on which to base a firmer conclusion that retarded children deal less adequately with problems of greater difficulty than their MA controls.

The results also indicate that stimulus complexity is a significant factor on all measures. One can conclude, therefore, that varying the number of irrelevant dimensions was a successful mode of varying task difficulty. Why is a 3VID problem more difficult than a 2VID problem? Osler and Kofsky (1965) suggested two reasons, memory load and strategy.

If the subject undertakes learning the problem by memorizing the reinforcement contingencies of each and every stimulus configuration, he will have to memorize many more configurations on the 3VID problems than the 2VID problems. As Osler and Kofsky suggested, success on the 2VID problems may reflect the ability to learn an 8-item paired associate list, and failure on a 3VID problem the inability to learn a 16-item list.

The child can, however, as Osler and Kofsky note, reduce the difficulty of the problems with a strategy of categorizing the stimuli according to dimension, thereby having to recall only three dimensions on the 2VID problems and four on the 3VID problems. This again raises the question why the 3VID problems are more difficult. It might be argued, as above, that memory load is a limiting factor; more children have the capacity to recall three dimensions than four.

Another more likely explanation is that the chance probability of attending to the relevant dimension is less with 3VID problems ($p = .25$) than with the 2VID problems ($p = .33$). Such an hypothesis is consistent with Zeaman and House (1963), who see discrimination as a two-stage process: (1) attending to the relevant dimension (e.g., form) and, having attended, (2) choosing the reinforced cue of that dimension (e.g., square). The 3VID problems are therefore more difficult in relation to the first stage, attending to the relevant dimension.

The data do not allow a conclusion as to which of the three explanations, memory for stimulus configurations, memory for dimensions, or chance probability of attending, accounts for the greater difficulty of the 3VID problems. It is, of course, possible that all these factors are involved, with different children employing different means of solution, and the same child using different means over trials. Some children may attempt to solve the problems by memorizing the reinforcement contingencies of individual stimulus configurations while others employ a strategy of matching reinforcements, whether systematically or haphazardly, to stimulus dimensions. Or a child may switch from one strategy to another. Whatever the individuals' strategies for solution may be, they all, in addition to the non-strategical chance probability of attending, make for more difficult solutions to the 3VID problems.

It is of interest to ask why retarded children perform, on the average, more poorly on the 3VID problems than the normals. If the reasons are of a cognitive nature, as Weir (1967) might suggest, then reasons for the poorer performance of retardates are related to the reasons why the 3VID problems are more difficult than 2VID problems. Since the chance probability of attending to the relevant dimension is the same for both groups, the reason must lie in memory load and/or strategy.

Retardates may have a poorer memory for a 16-item stimulus configuration list, but not for an 8-item list since they performed as well as normals on the 2VID problems. Alternately, in employing a strategy of categorizing stimulus dimensions, the retardates may have a poorer memory for a four-item list, although not a three-item list. A poor memory would result in a less efficient testing of dimensional hypotheses in that the inability to recall the results of a previously tested hypothesis would result in testing it again. It is not reasonable to assume that retardates are less inclined to use a strategy of categorizing dimensions since they performed as well as normals on the 2VID problems, presumably with the aid of such a strategy. There is no reason to assume, then, that they would be less inclined to use the dimensional categorization strategy on the 3VID problems.

An alternative to postulating cognitive deficiencies in the retarded is to apply social learning theory. Cromwell (1963) and others noted a lower expectancy of success in the retarded on various learning tasks. Stevenson and Zigler (1958) have shown that retarded children perform better (make more correct responses) than normal children of like MA on probability tasks with 67% and 33% reinforcement of correct responses. These results are interpreted in light of the theory that retardates have a lower expectancy of success and therefore pursue the partially reinforced response, while normal children attempted more variable behavior in an attempt to match reinforcements to their higher expected level of success. The results of the present study may be interpreted in similar fashion.

This is so in that responses to an irrelevant dimension, as well as random responding, is reinforced on a 50% random schedule. Retarded children might therefore show less inclination than normals to abandon an irrelevant dimension and seek the relevant dimension with 100% reinforcement. One would, in addition, expect this to be more true on the 3VID than the 2VID problems, since the initial attempts at solution of the former would probably prove more difficult. The normal child might persist in this attempt, while the retarded child would be more inclined to accept the 50% payoff on an irrelevant dimension. Gruen and Zigler (1968) have shown that retarded children are more likely to give up problem solving strategies that are not immediately reinforced than are normal children.

The social learning explanation of slower learning cannot be ruled out, although the cognitive explanations deserve equal consideration. Certainly this area deserves further study; experiments with greater stimulus complexity and designs shedding light on the role of various cognitive factors are needed.

Future studies should also take into consideration the role of concepts in varying task difficulty. The present study found task difficulty to be a function of both stimulus complexity and concept type. Previous studies designating size as the relevant dimension employed a concept relatively "easier" than form or color.

Concepts are not, of course, in themselves easier or more difficult than others. The relation is rather one of preference--this preference making the learning task easy or difficult. If the child prefers the relevant dimension, then, according to the attention theory of Zeaman and House (1963), learning is facilitated since his initial probability of attending to the relevant dimension is greater than chance. Conversely, if a child prefers an irrelevant dimension, his probability of attending to the relevant dimension is less than chance.

Suchman and Trabasso (1966b) reached a similar conclusion. Using nursery and kindergarten children who previously showed a consistent preference for either form or color, the authors found that children preferring color took significantly longer to learn a form-relevant discrimination than a color-relevant discrimination. Similarly, children preferring form took significantly longer to learn a color-relevant discrimination than a form-relevant discrimination. These results suggest that more children in the present study preferred form or size over color.

This conclusion appears reasonable in light of the findings of Suchman and Trabasso (1966a) and others of a developmental change in color-form preference. Older children tend to prefer form, while younger children prefer color. Suchman and Trabasso found that most of their subjects above 4 years 2 months preferred form; one can assume a similar preference in the subjects of the present study, whose mean CA was approximately 7 years. But it is perhaps unreasonable to generalize from the specific colors in the present study (red and blue) to color in general; less familiar colors may have resulted in more rather than less attention.

It might be argued, also, that older children are aided or impeded less in concept formation by their dimensional preference than the younger children in the Suchman and Trabasso (1966b) study; their inital probability of attending to their preferred dimension may be less than for younger children, and/or fewer nonreinforcements for older children may be required to abandon a preferred and irrelevant dimension. A similar distinction might be made between normal and retarded children, both as to preference and the effects of preference on concept formation. This is an area for further study.

Chapter IV

STUDY 3: INFORMATION PROCESSING IN FAMILIALLY-RETARDED AND NORMAL CHILDREN

Statement of the Problem

In order to further examine the performance of retarded and normal children on tasks of differing complexity, a problem-solving task employed by Niemark and Lewis (1967) was employed in this study. This task permitted a precise way of estimating and manipulating task complexity. The subject had to identify one of a number of patterns of binary elements. The total information required to identify one from among n patterns on this task is measured in terms of uncertainty H, and $H = \log_2 n$. Thus, when a subject had to identify one pattern of binary elements from among four, two bits of information were required for solution; when a subject had to identify one pattern from among eight, three bits of information were required for solution, etc.

In this study, retarded and normal children who were matched for MA were presented with both two-bit (four choice) and three-bit (eight choice) problems. Defect theory would lead to the prediction of differences in the problem-solving performance of these two groups attributable to IQ, while the developmental position would predict no differences. Weir's (1967) hypothesis would lead to the prediction that there would be differences in the problem-solving performances of retarded and normal children and that these differences should increase as task complexity increases (from two- to three-bit problems). The validity of these hypotheses was subjected to experimental test.

Method

Subjects

A total of 50 subjects, 25 normal and 25 retarded children, were employed in this study. The 25 retarded children were obtained from the special education classes at the Harry E. Wood School in Indianapolis, which is oriented toward the vocational training of inner-city children. The normal children were selected from a school in a small town in central Indiana. The Slosson Intelligence Test (SIT) (Slosson, 1963) was used to determine the MA and IQ scores of all subjects. Retardates evidencing gross sensory or motor dysfunction were not selected for the experimental tasks. This retardation was not classified but was presumed to be primarily of cultural-familial origin. The SIT was administered to the retarded children first. Then the normal children were tested, and if their MAs were within three months of the MA of subjects in the retarded group, they were selected for the experimental tasks. Thus, the mean and standard deviation of the MAs of the two groups were virtually identical. Table 11 presents the means and ranges of the CAs, MAs, and IQs of each group.

TABLE 11

Mean CA, MA, and IQ for Each Type of Subject

		CA (in years)		MA (in years)		IQ	
Group	N	M	Range	M	Range	M	Range
Normal	25	9.06	7.55-11.33	9.75	7.33-11.83	107.38	84.55-133.96
Retarded	25	16.09	15.25-17.67	9.76	7.67-12.00	60.63	49.20- 70.59

Apparatus

As stated above, the experimental tasks employed in this study were modeled after the problem-solving tasks developed by Niemark and Lewis (1967). In this task, the subject has to identify one of a number of patterns of binary elements. The total information required to identify one from among n patterns on this task is measured in terms of uncertainty H, and $H = \log_2 n$. On this task, two bits of information are required to solve problems having four possible patterns of binary elements and three bits of information are required to solve problems containing eight possible patterns. Thus, this task lends itself to an information analysis.

Figure 1 shows an example of a two-bit problem. The subject is given an answer sheet containing n numbered patterns, each composed of k binary elements (black or white circles), and a problem board in which one of those patterns is concealed under k movable shutters, one over each element. His task is to identify the concealed pattern by uncovering as few of its elements as possible. Figure 1 shows four patterns of four elements and a board with the shutter over element B opened to reveal a white circle below.

As Niemark and Lewis (1967) stated, "The potential information available to Subject is completely determined by the structure of the patterns on his answer sheet. The information he actually does obtain may be quantitatively described in terms of expected reduction in certainty. For brevity, the term 'strategy score' will be used to describe Subjects' actual information-gathering behavior as expressed in terms of mean expected informational outcome (in bits) of a series of shutter openings (moves). To see how this score is obtained, consider the four patterns in Figure 1. By opening shutters A or D, Subject will eliminate two of the four patterns as possible answers regardless of the state of the concealed element; such moves have an expected informational outcome of one bit of information and will be called 'safe moves.' By opening shutter B or C, on the other hand, Subject will have solved the problem (and obtained two bits of information) if the concealed element is black, but will have eliminated only one alternative (gotten .415 bits of information) if it is not. A move of this sort will be called a 'gamble.' Its expected information outcome, E_1, is obtained by weighting each informational outcome by its likelihood of occurrence (assuming that patterns are

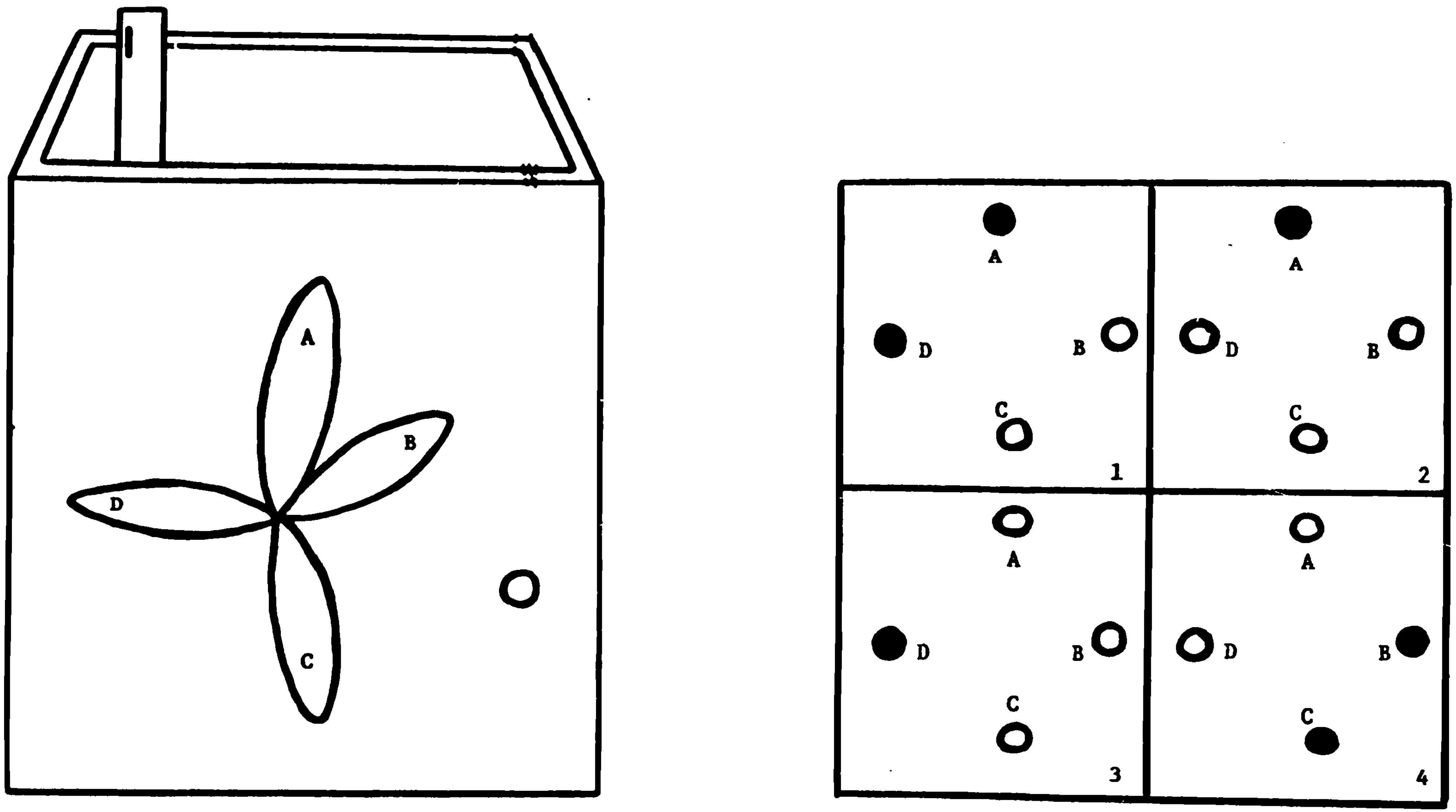

Figure 1. Schematic of a problem board with four shutters and an answer array containing four patterns.

equally likely to be concealed in the board): E = .25 (2 bits) + .75 (.415 bits) = .811 bits. These values may be obtained directly from tables of $p \log_2 p$."

The average strategy score was obtained in this study by summing the expected informational outcome, E_1, of each successive move over all i moves and dividing the sum by the number of moves. Thus, the maximal possible value was unity, and this value could result only from a series of safe moves. In order to be consistent with Niemark and Lewis, this strategy will be called a safe strategy. This strategy score is lowered either by gambling or by making non-informative (redundant) moves. An example of a redundant move in Figure 1 would arise if the subject opened shutter C after first having opened shutter B (or vice versa).

Procedure

The task was first demonstrated to the subject with an example in which there were four patterns and a problem board with three shutters. The experimenter opened one shutter and, after asking the subject to eliminate the patterns which were no longer appropriate, asked him which shutter should be opened next. Of the two remaining moves, one was non-informative while the other solved the problem; regardless of the subject's choice, this fact was pointed out to him. The subject then was given a series of four practice problems to familiarize himself with the details of the procedure.

After mastering the mechanics of the procedure, the subject began the series of eight experimental problems for which the procedure was as follows: when the subject opened a shutter, the experimenter wrote the letter designating its position on the appropriate line of the subject's answer sheet, which was in view of the subject. (Each answer sheet for each problem was obtained by permuting (a) shutter positions within a pattern and (b) arrangement of patterns on a page.) The experimenter then placed a cover on the face of all patterns thereby eliminated as possible solutions. When he obtained a solution, the experimenter wrote its identifying number on a line labelled "answer." The experimenter then closed all shutters and removed the problem from the board, after which the subject was presented with the next problem and its accompanying answer sheet.

Four of the eight experimental problems were two-bit problems (required two bits of information for solution) and four were three-bit problems. The set of two-bit problems was administered before the set of three-bit problems, but within each set the order of administration of the problems was determined according to random sequence. All subjects were presented with this same sequence. Each answer sheet was so constructed that, as a first move, half of the available moves were safe moves and the remaining half were gambling moves.

The total number of patterns involved in a given problem (either four or eight), each on a tabbed cardboard square, were loaded in a 9-inch wooden board with either four or eight movable shutters equally spaced around the circumference of a circle 8 inches in diameter.

The exact instructions for the practice and experimental problems are given below.

3-Choice Problems

"I am going to show you some things that are kind of like puzzles. Do you see these shutters here, A, B, and C?" (Point to each shutter.) "Under each shutter is either a black circle or a white circle. Here are two patterns of circles (point). One of these two patterns is hidden under the shutters. The object is for you to find out which one of these two patterns is the one hidden under the shutters by opening as few shutters as you can...if you had to open all three shutters to figure out which pattern is hidden, that would not be as good as if you only had to open two of the shutters. The less shutters you have to open the better."

"Now, one of these three shutters is better to open than the others. Can you figure out which one we should open first?"

(If the subject says A): "Yes, that's right. Do you know why? It is A because the A's are different, aren't they? (point) And so the A shutter will tell you which of the patterns it is by opening only one shutter. (Open A) A turns out to be black, so of course it must be pattern number 2 that is under the shutters."

"What would have happened if you chose B instead of A? You still wouldn't know which pattern it is, because the B's are the same in both pattern 1 and pattern 2. So you would have to open A, too. You would have to open both shutters if you chose B first. B is a bad choice because it doesn't help you find out anything about which pattern is hidden and it means you would have to open two shutters instead of one. C is just like B, a bad choice."

"Do you see how this works? Let's try another one."

(If the subject says B): "No, that's not the best shutter to open, because both these patterns have black B's (point), don't they? Opening B won't tell you anything about which pattern is hidden, so you'd have to open shutter A also in order to know for sure which pattern is hidden."

"But what if you opened shutter A first? The A's are going to be different (point), and so opening A will tell you which of the two patterns it is. You won't have to open the other shutter. (Experimenter opens A.) A turns out to be black, and so of course it is pattern number 2 that is under the shutters."

"Do you see how this works?"

"Let's try another one." (The two 3-choice problems were presented twice, alternately.)

4-Choice Problems

"Now that you understand how these problems go, I'm going to show you some that are in this board. Here are the shutters, A, B, C, and D. And over here on your answer sheet are shown four different arrangements of black and white circles, one of which is under these shutters. As I told you before, the object is to find out which one of these patterns is under the shutters by opening up as few shutters as possible. Do you understand? All right, go ahead." (If the subject acted confused, the experimenter said, "You do the same thing as you were doing before.") "I'll write the letter of the shutter you are opening down here and we'll cover up all the patterns that shutter eliminates by placing a cover on the face of the patterns."

"All right, now there is a new problem in the board that goes with the next answer sheet. Try this one."

(Later) "O.K., now try this one."

8-Choice Problems

"Now here is a board with eight shutters on it. On your answer sheet there are eight different arrangements of black and white circles. Once again, the problem is to identify which of the eight patterns of circles is hidden under the shutters by opening as few shutters as possible. You just do the same thing you were doing before. All right? Then go ahead."

Results

The performance of the 25 retarded children was compared with the performance of the 25 normal children on five dependent variables: (1) the total number of moves made by each subject in attempting to solve the tasks (a smaller number of moves reflected a more efficient solution); (2) the number of non-informative or redundant moves (moves which added no new information to that already obtained through previous shutter selections); (3) the mean reaction time between the presentation of each problem and the subject's first response; (4) the number of gambling moves (as defined above); and (5) the strategy score used by Niemark and Lewis (1967) (defined above). Furthermore, since the retarded and normal group differed in terms of chronological age (CA), both analyses of variance and covariance (with CA as the covariate) were performed on several of these dependent variables.

Total Number of Moves Analysis

The 2 X 2 analysis of variance and covariance (two levels of intelligence, normal and retarded, and two levels of problem difficulty, 4-choice and 8-choice) for total number of moves is presented in Table 12.

TABLE 12

Summary Table for the Analysis of Variance
and Covariance for Total Moves

Source	df	MS	F	p
A. Intelligence	1	23.04	1.41	
Subject w. A	48	16.35		
B. Problem difficulty	1	1797.76	141.89	<.01
AB	1	4.00	<1	
Residual	48	12.67		
A (adjusted)	1	65.35	4.19	<.05
Subject w. A (adj.)	47	15.59		

This analysis revealed a significant main effect for problem difficulty ($p < .01$) and intelligence ($p < .05$). The main effect for problem difficulty occurred because the 8-choice task required more moves to solution ($\overline{X} = 19.20$) than did the 4-choice problem ($\overline{X} = 10.72$). The significant effect for intelligence occurred only when CA was held constant by means of the covariance analysis (the effect for intelligence was not significant in the analysis of variance). This significant effect for intelligence occurred because the retarded children required more moves to solve both problems ($\overline{X} = 15.44$, mean adjusted for CA = 18.81) than did normal children ($\overline{X} = 14.48$, mean adjusted for CA = 11.11).

Non-informative Moves Analysis

The 2 X 2 analysis of variance and covariance for non-informative moves (presented in Table 13) revealed only a significant effect for problem difficulty ($p < .01$). This effect occurred because both normal and retarded children made more non-informative moves on the 8-choice ($\overline{X} = 4.7$) than on the 4-choice ($\overline{X} = 1.3$) tasks. The covariance analysis indicated only a nonsignificant trend ($p < .10$) for retarded children to make more non-informative moves ($\overline{X} = 3.50$, mean adjusted for CA = 6.45) than normal children ($\overline{X} = 2.48$, mean adjusted for CA = -.47).

TABLE 13

Summary Table for the Analysis of Variance and Covariance for the Number of Non-informative Moves

Source	df	MS	F	p
A. Intelligence	1	26.01	1.70	
Subject w. A	48	15.28		
B. Problem difficulty	1	292.41	34.67	<.01
AB	1	2.25	<1	
Residual	48	8.43		
A (adjusted)	1	52.20	3.54	<.10
Subject w. A (adj.)	47	14.76		

Reaction Time Analysis

The 2 X 2 analysis of variance and covariance for mean reaction time revealed no significant main effects (see Table 14), although the interaction between intelligence level and problem difficulty approached significance. (The critical value of $F_{.95}$ is 4.04 while the obtained F is 4.03.) This trend occurred because normal children tended to respond more rapidly on the 4-choice problem than on the 8-choice problem ($\overline{X}$ = 7.10 and $\overline{X}$ = 9.37, respectively), while the converse was true for the retarded children ($\overline{X}$ = 8.52 and $\overline{X}$ = 8.02, respectively).

TABLE 14

Summary Table for the Analysis of Variance and Covariance for Reaction Time to Problems

Source	df	MS	F	p
A. Intelligence	1	.03	<1	
Subject w. A	48	51.09		
B. Problem difficulty	1	19.56	1.64	
AB	1	47.93	4.03	≈.05
Residual	48	11.89		
A (adjusted)	1	31.36	<1	
Subject w. A (adj.)	47	51.47		

Gambling Moves

The mean number of gambling moves made was identical for normal and retarded children ($\bar{X}$ = 5.2, t = .14, df = 48, p > .05). The observations of the experimenter suggested that when "gambling" moves occurred, they often were not the result of a conscious attempt to take a chance. Rather, they seemed to be a result of confusion or lack of understanding on the subject's part. More "gambling" moves were made on the 8-choice ($\bar{X}$ = 3.28) than 4-choice ($\bar{X}$ = 1.92) task (t = 4.56, df = 48, p < .05), but this was probably a result of the greater opportunity for variability of response choices.

Strategy Scores

As stated before, the strategy score is obtained by summing the expected informational output, E_1, of each successive move over all i moves and dividing the sum by the number of moves. The maximal possible value is unity for both the 4-choice and 8-choice problems, while random responding would result in a strategy score of .68 for the 4-choice and .65 for the 8-choice problems. The retarded and normal children did not differ in their performance on the 4-choice problems (means = .85 and .88, respectively; t = 1.009, df = 48, p > .05), but they did on the 8-choice problems (means = .69 and .77, respectively; t = 2.89, df = 48, p < .01). Within each group, the strategy scores were higher on the 4-choice than the 8-choice problems. The mean strategy scores for the normal children on the 4- and 8-choice problems were .88 and .77, respectively (t = 4.11, df = 24, p < .01), while those for the retarded children were .85 and .69, respectively (t = 5.29, df = 24, p < .01).

Position Preferences

A further analysis revealed that both normal and retarded children demonstrated a position preference on their initial choice for each problem. This position preference is summarized in Table 15.

TABLE 15

Total Number of Subjects Selecting Each Shutter Alternative on Their Initial Choice for Each Problem

Normal					Retarded				
4-choice:	A	B	C	D	4-choice:	A	B	C	D
	45	21	16	18		28	26	22	24
8-choice:	A	B	C	D	8-choice:	A	B	C	D
	42	8	0	4		39	8	13	6
	E	F	G	H		E	F	G	H
	14	7	5	10		10	7	8	9

Normal children differ significantly from chance in their selection of shutter position, regardless of the amount of information obtained from any position, on both the 4-choice ($\chi^2 = 21.84$, df = 3, $p < .001$) and the 8-choice ($\chi^2 = 84.32$, df = 3, $p < .001$) tasks. Retarded children significantly demonstrated such a greater than chance position preference only on the 8-choice tasks ($\chi^2 = 66.72$, df = 3, $p < .001$). As indicated by Table 15, the favored shutter position for both normal and retarded children tended to be position "A."

The Relationship of CA, MA, and IQ to the Dependent Variables

Tables 16 and 17 show the correlations of CA, MA, and IQ with each of the dependent variables for the retarded and normal children, respectively. To be significant at the .05 level the correlation coefficient must exceed .38 in each group. It can be seen in Table 16 that neither CA, MA, nor IQ were significantly related to the problem-solving performance of the retarded children. However, for the normal children, MA was significantly related to Total Moves, Non-informative Moves, and Strategy scores while IQ was significantly related only to Total Moves. The generally lower correlations for the retarded than the normal children may partially be a result of their relatively more restricted ranges of CA and IQ (see Table 11). It should also be noted that CA was positively related with IQ in the retarded group but negatively related with IQ in the normal group.

TABLE 16

The Correlations of CA, MA, and IQ with Several of the Dependent Measures for the Retarded Children

	1	2	3	4	5	6	7	8	9	10
				Total Moves		Non-infor. Moves		Reaction Times		
	CA	MA	IQ	4-Ch.	8-Ch.	4-Ch.	8-Ch.	4-Ch.	8-Ch.	Strategy Score
1		.65**	.55**	-.32	-.15	-.20	-.17	.15	.22	.17
2			.99**	-.20	-.28	-.12	-.30	.35	.31	.31
3				-.18	-.30	-.12	-.32	.37	.32	.18

** $p < .01$

TABLE 17

The Correlations of CA, MA, and IQ with Several of the Dependent Measures for the Normal Children

	Variables									
	1	2	3	4	5	6	7	8	9	10
	CA	MA	IQ	Total Moves 4-Ch.	Total Moves 8-Ch.	Non-inform. Moves 4-Ch.	Non-inform. Moves 8-Ch.	Reaction Times 4-Ch.	Reaction Times 8-Ch.	Strategy Score
1		.39*	-.30	-.21	-.26	-.11	-.27	.19	-.09	.22
2			.76**	-.53**	-.58**	-.42*	-.50**	-.08	-.01	.56**
3				-.40*	-.43*	-.35	-.33	-.20	.06	.37

* p < .05
**p < .01

Discussion

Before discussing the significance of these findings for the controversy between the general developmental and defect theorists' positions with regard to mental retardation, a few comments concerning the tasks employed in this study should be made. First of all, it should be emphasized that these tasks require the application of a formal principle, the "safe strategy," for solution. Thus, only children who are relatively advanced in their cognitive development (have relatively high MA's) could be expected to solve them. A child would most likely have to be at Piaget's (1950) formal-operational stage of development to consistently apply such a formal principle. Secondly, it should be noted that the same formal principle can be applied to either the 4-choice or 8-choice tasks. That is, these tasks differed in the amount of information they presented for the child to process and to which the child had to apply the formal principle, but not in the principle required itself. Thirdly, the results indicate that the 8-choice task was consistently more difficult than the 4-choice task. Both normal and retarded children took more moves to solution, made more non-informative moves, and had lower strategy scores on the 8-choice task. Thus, these tasks were appropriate for a test of Weir's (1967) hypothesis that differences in the problem-solving performance of normal and retarded children should increase as task complexity increases for two reasons: (1) they are at a high level of difficulty to begin with, and (2) the 8-choice task is more difficult than the 4-choice task.

Nevertheless, the results of this study must be interpreted with great caution in regard to the developmental versus defect positions of mental retardation. The actual performances of the normal and retarded children matched for MA did not differ in the total number of moves, number of non-informative moves, overall reaction times to first response, or number of gambling moves on either the 4-choice or 8-choice tasks. On the surface, these findings would appear to support Zigler's developmental position. However, normal children did obtain higher strategy scores on the 8-choice task than retarded children, even though their performance did not differ on the 4-choice task. This latter finding is consistent with Weir's (1967) hypothesis but not Zigler's.

To further complicate matters, when variance due to chronological age is partialled out by means of covariance analysis, retarded children tend to make more moves to solve the problems and make more non-informative moves than normal children. These analyses suggest that some variable(s) not measured in this study but correlated with CA has a significant effect on performance on these tasks. One class of variables that may be so correlated with CA are ability factors. The retarded and normal children in this study were matched for MA on the basis of their scores on the Slosson Intelligence Test (SIT) which is essentially a verbally-loaded, g-factor type of test. It may well be that other ability factors not tapped by the SIT and correlated with CA are significantly related to performance on the problem-solving tasks employed in this experiment.

A second possibility is that experiential factors not directly related to cognitive abilities but associated with greater CA significantly affect performance on these problem-solving tasks. This interpretation gains some support from the correlations presented in Tables 16 and 17. In these tables it is shown that MA was significantly related to total moves made, non-informative moves, and strategy scores, and that IQ was related to total moves made in the normal group; but neither MA nor IQ were significantly related to problem-solving performance in the retarded group. Combined with the previously mentioned covariance analyses, these tables suggest that non-cognitive factors may account for more of the variance in the performance of the retarded children than in the performance of the normal children. If this interpretation is a correct one, it reinforces the general developmental theorists' point of view that performance on any experimental task is not the product of the subject's cognitive structure alone, but is also influenced by a variety of emotional and motivational factors as well. These differences, of course, do not inhere in mental retardation but are rather the result of the particular life histories of the typical retarded subject.

A third interpretation of these data reinforces the idea that non-cognitive factors account for the differences in the performance of the normal and retarded children. Since the effects of MA were eliminated by matching and the effects of CA were eliminated by covariance analysis, one could argue that the effects of IQ were also eliminated because IQ is totally determined by MA and CA. If this is true, then the differences found between the two groups of subjects in their problem-solving performance must be due to non-cognitive factors. However, this does not imply that non-cognitive factors played an equal role in determining the performance of normal and retarded children. The argument presented in the preceding paragraph suggests that the normal children's performance is heavily dependent on cognitive factors while the retarded children's performance is more greatly influenced by non-cognitive factors.

Further evidence that non-cognitive factors played a larger role in affecting the performance of retarded than normal children is provided by the interaction that occurred between intelligence and problem difficulty on the variable reaction time to first move. One would expect generally slower reaction times on the 8-choice than the 4-choice because there is more information to process; and this did, in fact, occur with the normal children. However, the retarded children actually responded more rapidly on the 8-choice than 4-choice problems. This suggests that the retarded children may have been overwhelmed by the amount of information presented in the 8-choice problems and just responded randomly. This interpretation is supported by the fact that the mean strategy score of the retarded children (.69) was very close to what would be expected if they had responded randomly (.65). Thus, the general developmentalist's emphasis on non-cognitive factors that result in differential performances of normal and retarded children seems well-taken. On the other hand, the normal children's generally more efficient use of information (as indicated by their higher strategy scores) than retarded children in this study prevents a clear statement that normal and retarded children matched for MA do not differ cognitively. The interaction of both non-cognitive and cognitive factors in determining the problem-solving performances of children on these tasks and the difficulty in completely separating them experimentally is well-illustrated by this study.

Finally, there were a number of problems encountered in administering these tasks that should be mentioned. The instructions finally employed in this study were arrived at only after considerable revising on the basis of pilot testing with both normal and retarded children. In spite of the numerous revisions, the subjects often seemed confused by the instructions. The practice problems with the 3-choice task were most helpful in getting across to subjects the essentials of the task requirements. The positive bias in both normal and retarded children to choose shutter A (at the top of the board) was another troublesome aspect of this task. However, the reliable differences found between performance on the 4-choice and 8-choice task indicate that this task could be very useful in experiments where it is necessary to systematically vary the complexity.

Chapter V

STUDY 4: PERSONALITY CHARACTERISTICS RELEVANT TO THE DIFFERENTIAL PERFORMANCE OF FAMILIALLY-RETARDED AND NORMAL CHILDREN ON LEARNING TASKS

Statement of the Problem

The purpose of this study was to attempt to determine the nature of the non-cognitive factors that may have contributed to the differential learning and problem solving performances of retarded and normal children in Studies 2 and 3. Since the retarded and normal children in these two studies differed in socio-economic background and other life-history factors, it was thought that personality characteristics closely related to such life-history differences would be the ones most likely to be related to performance differences. This reasoning was buttressed by the fact that relatively few differences were found in the performances of retarded and normal children in Study 1 where the retarded and normal children came from quite comparable socio-economic backgrounds.

Several specific personality variables thought to be related to such life-history differences and included in this study were need for achievement (Atkinson, 1958), locus of control (Miller, 1965), level of aspiration (Diggory, 1966), expectancy for success (Diggory, 1966), and test anxiety (Sarason, 1958). In this study, scores obtained by retarded and normal children on measures of these variables were related to their performance on a criterion learning task. The criterion learning task was a particular type of three-choice discrimination task in which only one stimulus was partially reinforced, the other two yielding zero-reinforcement (Weir, 1964). On this task, two typical modes of responding that are employed by children are maximizing (repeatedly choosing the partially reinforced stimulus) and patterning (choosing all three stimuli in a left, middle, right [LMR] or right, middle, left [RML] fashion) (Weir, 1964). Stevenson and Zigler (1958), Gruen and Zigler (1968), and Ollendick, Balla, and Zigler (1971) have all found that laboratory manipulations of failure experiences prior to performance on this criterion task result in a higher incidence of maximizing behavior. Success experiences, on the other hand, result in a higher incidence of LMR and RML patterning responses. Further, children with life-histories of failure or success experiences in learning situations have been found to perform in similar patterns on this task (Kier & Zigler, 1969; Gruen & Zigler, 1968; Stevenson & Zigler, 1958). The authors of these studies have generally interpreted these findings within a social learning framework. They have argued that prior failure experiences cause children to expect and settle for lower degrees of success than do prior success experiences (Stevenson & Zigler, 1958). Further, prolonged histories of failure in learning situations can cause children to develop entrenched negative attitudes toward learning and to have little confidence in their problem-solving abilities (Gruen & Zigler, 1968). Gruen and Zigler (1968) found that when the highest cognitive strategy which children with long failure histories were capable of generating was not immediately reinforced, these children quickly stopped searching for a solution to the problem and resorted to more primitive cognitive strategies.

The premise of the present investigation was that long-term patterns of success-failure experiences occurring throughout a child's developmental period are the primary etiological factor in the development of these personality characteristics. In turn, these personality characteristics, once established, mediate the reactions of children to further encounters with success or failure in learning situations. Thus, on a criterion learning task such as the one employed in this study in which partial reinforcement makes both success and failure inevitable, personality characteristics such as those described above should be significantly related to the learning performance. A recent series of investigations has, in fact, shown that expectancy of success (Kier & Zigler, 1969), level of aspiration (Gruen, Ottinger, & Zigler, 1970), need for achievement (Ollendick, Balla, & Zigler, 1971), and internal-external locus of control (Gruen & Ottinger, 1969) are significant determiners of performance on this three-choice learning task. Consistent with the arguments mentioned earlier to account for the effects of success-failure experiences on performance on this task, these studies have found that elementary school-aged children with high expectancies of success, high levels of aspiration, high n Achievement, and an "internal" control orientation tend to predominantly exhibit patterning behavior on this task, while children at the other end of these personality dimensions predominantly exhibit maximizing behavior.

In the present study an attempt was made to extend this body of research by relating performance on this learning task to one more personality variable, test anxiety (Sarason, 1958), and then to systematically examine the relationships among these personality characteristics to each other. Both the amounts of variance these variables have in common and their relative predictiveness of performance on the criterion learning task were examined within two populations of children, normal and moderately retarded. It was hoped that this study would help to pinpoint specific personality characteristics that contribute to differential learning performance in retarded and normal children.

Method

Subjects

A total of 45 subjects was employed. Fifteen noninstitutionalized retarded children were drawn from special classes in the public schools of Tippecanoe County, Indiana. These subjects were all diagnosed as familial retardates and none exhibited gross sensory or motor disturbances. Two groups of 15 normal children were also selected from the same school district. The first group was matched with the retarded subjects for mental age (MA), and the second group was matched with the retarded subjects for chronological age (CA). An individually-administered intelligence measure, the Peabody Picture Vocabular Test, Form B (1959), was used to obtain all MA and IQ scores.

TABLE 18

Mean CA, MA, and IQ for Each Type of Subject

Group	N	CA (in months) Mean	CA (in months) Range	MA (in months) Mean	MA (in months) Range	IQ Mean	IQ Range
Retarded	15	119.3	101-136	90.2	84-99	68.4	63-78
Normal							
MA-matched	15	93.4	78-94	88.9	83-96	108.4	92-129
CA-matched	15	121.1	100-138	123.7	102-153	102.3	91-118

Mediating Variables

The following data were gathered to serve as mediating variables affecting performance on the probability learning task. All of these measures were assumed by the authors to reflect life histories of success and failure experiences.

The Locus-of-Control (LOC) Scale was devised by James Miller (1965) as a modification of the Bialer Locus-of-Control Scale (1961). The 24 items of this scale require only a "yes" or "no" response. Lower scores on this scale indicate external control. "When nice things happen to you, is it only good luck?" is an example of an item from this scale. A "yes" response to this question indicates an external locus of control, whereas a "no" response indicates an internal locus of control.

Measures of expectancy of success (E) and level of aspiration (Asp) were obtained from the card-sorting task originally devised by Diggory (1966). This task was modified sufficiently to be understood by children at this developmental level. The task employed 24 2" by 3" cards with a geometrical shape drawn in the center portion of each card. There were six different shapes so that the same designs appeared on four of the cards. The goal of the task is to sort the 24 cards in 30 seconds within the allotted ten trials. Although the subject is told that he will be allowed 30 seconds to sort the cards each time, he is stopped after a predetermined number of cards have been correctly sorted. Before each turn, the subject is asked two questions. The first question measures the subject's expectancy of success: "How sure are you that you will sort 24 cards at least once before you use up all ten of your turns?" The subject indicates how sure he is of achieving the goal by choosing a statement on a five-point scale varying from "I'm sure I can't" to "I'm sure I can." A level of aspiration estimate is also obtained before each turn by asking the subject "How many cards are you going to try to sort on this next turn?" Mean level of aspiration scores across the ten trials as well as first estimates are obtained from this task for both measures.

Need for achievement (n Ach) was assessed through a series of three cards taken from the Thematic Apperception Test and scored according to the method of content analysis described in Atkinson (1958). This measure reflects the individual's need to achieve and motive to succeed in achievement-related situations. A measure of test anxiety was obtained from the Sarason Test Anxiety Scale for Children (TASC) (Sarason, 1958). This scale reflects the degree of fear of failure in achievement situations.

Criterion Task

The apparatus used for the criterion learning task is described in detail elsewhere (Stevenson & Zigler, 1958). Essentially it consists of a yellow panel with a horizontal row of three round black knobs on the face of it. A red signal light is located above these knobs, and a hole through which marbles can be delivered is located below these knobs. These marbles fall into a plastic container.

Procedure

Each subject was given all four personality measures in one session, the criterion task was administered by a different experimenter five to ten days following the personality test administration to minimize the effects of subjectively felt success and failure on the personality tests.

The first personality measure assessed was Locus-of-Control. This test was administered orally to all subjects, and their responses (yes or no) to the test items were checked and their scores totaled at a later time.

The Need for Achievement scale was administered next and consisted of all subjects telling stories to a set of three pictures. These stories were scored for n Ach at a later date by an advanced graduate student whose scoring reliability was established at .89 (Atkinson, 1958).

The third personality measure assessed was the Sarason Test Anxiety Scale for Children. The scale was administered orally to all subjects, and their responses (yes or no) to the scale items were checked and their scores totaled at a later time.

The measure of expectancy of success and level of aspiration was then assessed. All subjects were told that this was a card-sorting game and that if they sorted all the cards in 30 seconds in one of the ten trials, they could win a prize. Before each trial, all subjects were asked two questions: "How sure are you that you will sort the 24 cards at least once before you use up all ten of your turns?" and "How many cards are you going to try to sort on this next turn?" Responses to these two questions were recorded for each trial. Although subjects were told that they would be allowed 30 seconds to sort the cards each time, they were stopped after a pre-determined number of cards had been correctly sorted. Thus, performance feedback was constant for all subjects. Subjects were permitted to sort 11 cards correctly on the first trial and to improve over trials until 24 cards were correctly sorted on the last trial. All subjects received a prize for their performance on this last measure, thanked for their cooperation, and told they would be seen again in about a week.

Approximately one week following the personality testing, each subject was seen by the second experimenter and presented the three-choice probability learning task. Each subject was seated in front of the apparatus and told that he was going to play a game. Subjects were told that each time the red light came on they should push the knob they thought would win them a marble and that if they won enough marbles, they could exchange them at the end of the game for a prize. All subjects were told to try to win as many marbles as possible.

In all groups, one knob was reinforced 66% of the time it was pushed and the other two knobs were never reinforced. Reinforcement was thus available on 66% of the total trials. For each subject one of the three knobs (either left, middle, or right) was designated as the correct knob. Five subjects in each group were reinforced for choosing the left knob, five for choosing the middle knob, and five for choosing the right knob. All subjects were given 120 trials on this task. At the completion of the task, all subjects were told that they did very well in the game and that they had won more than enough marbles to win a prize. They were then given the prize of their choice, praised again for their performance on the task, and returned to their classroom.

Results

Analyses of Personality Measures

The mean scores made on seven dependent variables by subjects in each of the three groups are presented in Table 19. It should be remembered that higher scores on the LOC Scale indicate more internal control. High scores on the n Ach measure reflect high n Ach, and high scores on the Test Anxiety Scale for Children (TASC) indicate high anxiety. The other four dependent variable scores are derived from the Diggory Task: E_1 and Asp 1 refer to the subjects' first responses to the expectancy of success and aspiration measures; $\overline{E}$ and $\overline{Asp}$ refer to their average expectancies of success and average aspiration estimates over ten trials.

TABLE 19

Mean Scores Made by Each Type of Subject on the Dependent Measures

	LOC	n Ach	TASC	E_1	Asp 1	$\overline{E}$	$\overline{Asp}$
Retardates	15.50	16.24	9.53	4.03	15.49	3.98	18.71
Normal							
MA-matched	14.58	14.78	10.81	3.83	16.61	3.58	18.52
CA-matched	20.29	15.68	9.63	3.47	14.71	3.41	18.47

A series of 2 X 3 factorial analyses of variance (Sex X Type of Subject) revealed no significant differences between groups on any of these dependent measures except LOC ($F = 18.52$, $df = 2$ and 39, $p < .0001$). This main effect occurred because the normal children matched for CA with the retarded children were significantly more internal than either the retarded or MA-matched children.

The interrelationships among these dependent variables across all groups are shown in Table 20. It can be seen from this table that LOC and n Ach did not correlate significantly with each other or any of the other variables. Scores on the TASC, however, did have a significant relationship with subjects' first statements of expectancy for success and with their mean aspiration level scores over ten trials. The negative correlations indicate that higher anxiety scores were associated with lower expectancies for success and lower aspiration levels. The various measures derived from the Diggory Task also showed significant relationships to one another. Subjects' first stated expectancies were related to their average expectancies as well as to their aspiration levels. Similarly, their first level of aspiration statement related significantly to their average aspiration levels as well as the first expectancy statement. However, no significant relationship between average expectancies and either of the two level of aspiration measures was found.

TABLE 20

Intercorrelations Among the Dependent Variables

	1	2	3	4	5	6	7
	LOC	n Ach	TASC	E_1	Asp 1	$\overline{E}$	$\overline{Asp}$
1		.174	.015	-.059	.171	-.162	.200
2			-.119	.064	.044	.101	-.039
3				-.342*	-.130	-.188	-.331*
4					.422**	.584**	.378**
5						.153	.493**
6							.058
7							

* $p < .05$
**$p < .01$

Relationship of Personality Measures to Probability Learning

Two multiple regression analyses were performed to determine the combined accuracy with which these seven personality variables could predict performance on the probability learning task. Table 21 presents the results of a stepwise regression analysis with number of correct responses

(CRs) made on the learning task as the criterion variable. It can be seen that n Ach was the only predictor that was significantly related to CRs, the other predictors adding nothing to the prediction equation. The overall multiple R was .379. The correlation between n Ach and CRs was actually negative (.309) in direction, indicating that children with higher n Ach scores made less CRs. This was the predicted direction for this relationship.

TABLE 21

Multiple Correlation Summary Table for Correct Responses

	Multiple			
Variable	R	R-Squared	Increase in RSQ	p
n Ach	.309	.095	.095	.05
LOC	.341	.126	.031	NS
TASC	.366	.134	.008	NS
Asp 1	.373	.139	.005	NS
E	.378	.143	.004	NS
E_1	.379	.144	.001	NS
Asp	.379	.144	.000	NS

Table 22 presents the results of a second regression analysis performed with number of variable responses made in the process of making LMR or RML pattern responses (PRs) as the criterion variable. A multiple correlation coefficient of .44 was obtained in this analysis. Although n Ach was again the best predictor, LOC significantly contributed to n Ach in the prediction of PRs. Both were positively related to PRs.

TABLE 22

Multiple Correlation Summary Table for Pattern Responses

	Multiple			
Variable	R	R-Squared	Increase in RSQ	p
n Ach	.324	.105	.105	.05
LOC	.380	.144	.039	.05
Asp 1	.403	.162	.018	NS
Asp	.425	.181	.019	NS
E_1	.434	.188	.009	NS
TASC	.439	.193	.005	NS
E	.440	.194	.001	NS

Group Comparisons on the Probability Learning Task

A 2 (Sex) X 3 (Type of Subject) X 6 (Blocks of 20 Trials) factorial analysis of variance performed on the number of CRs made revealed no reliable effects due to Sex or Type of Subject. However, a significant Trials effect ($F = 43.69$, $df = 5$ and 195, $p < .001$) and a Trials X Type of Subject interaction did occur ($F = 3.61$, $df = 10$ and 195, $p < .001$). Table 23 shows that the Trials effect occurred because of a general increase in CRs made over blocks of trials. It can also be seen that the normal children matched for CA with the retarded children showed a greater increase in CRs over trials than the other two groups. This was the source of the Trials X Type of Subject interaction effect.

TABLE 23

Mean Number of Correct Responses Made by Each Type of Subject

	Blocks of 20 Trials					
	1	2	3	4	5	6
Retarded	10.08	11.43	11.80	12.72	12.63	13.06
Normal						
MA-matched	9.80	11.44	12.28	13.42	14.33	14.08
CA-matched	9.16	11.91	14.61	14.74	16.22	16.58

A 2 X 3 analysis of variance performed on the number of CRs made on the last block of 20 trials revealed no significant effects due to either Sex or Type of Subject.

A 2 X 3 X 6 analysis of variance performed on the number of PRs made revealed only a significant Trials effect ($F = 8.68$, $df = 5$ and 195, $p < .001$). This effect occurred because the number of PRs made decreased significantly from the first block of trials ($\bar{X} = 1.73$) to the sixth block of trials ($\bar{X} = 1.03$).

Discussion

The results of this study were generally disappointing. None of the personality measures employed in this study reliably differentiated between retarded children and the normal children matched for MA with them. Only one variable, locus of control, differentiated between retarded children and the normal children matched for CA with them. Since previous studies have reported differences between retarded and normal children on several of these variables (see Cromwell, 1963), the lack of differences in the present study suggests that we employed an unusual sample of retarded children. Perhaps their experiences in special education classes have included a great deal of success experiences, making them atypical for retarded children.

This hypothesis is supported by the finding of no differences between retarded and normal children on the probability learning task. Previous studies (Stevenson & Zigler, 1958; Gruen & Zigler, 1968) have typically found that retardates make more CRs and less PRs than MA-matched normal children. These studies have been generally interpreted as being a result of the greater failure experiences incurred by retarded children than normal children. Because they fear failure and have lower expectancies for success, they are willing to settle for the partial success provided by repeatedly choosing only one stimulus on the three-choice learning task. That this did not occur in the present study is further evidence that the retarded children employed were atypical.

It is surprising also that the intercorrelations among the personality variables were so small. If the personality characteristics measured do indeed result from patterns of success-failure over the developmental period, as was suggested in the introduction to this chapter, one would expect more overlap and higher correlations among them. However, these correlations may be low for the same reason that no differences were found between groups on these personality measures--namely, the range of scores was too restricted.

The most solid finding in this study was that n Ach is a significant predictor of learning performance. Whether CRs or PRs were used as the criterion variable, n Ach was the best predictor. This finding confirms a previous finding by Ollendick and Gruen (1971) that children with high n Ach scores tend to make less CRs and more PRs than children with low n Ach scores. It is also consistent with the argument derived from social learning theory and referred to above. Apparently, high n Ach children are not satisfied with the partial success resulting from repeatedly choosing the reinforcing stimulus (CRs) and tend to vary their responses looking for greater payoff. There is some evidence in this study that internally-controlled children tend to respond in a similar manner. This also is consistent with previous investigations (e.g., Gruen & Ottinger, 1969).

One of the main purposes of this study was to try to identify personality characteristics that might partially account for the learning and problem-solving performance differences of retarded and normal children in Studies 2 and 3 of this report. The safest conclusion that can be made in that regard is that n Ach and LOC offer the most likely sources to look for such factors. Future studies attempting to further account for retarded-normal differences in learning or problem-solving performance should include these variables.

Chapter VI

CONCLUSIONS

The main purpose of this series of studies was to experimentally test the relative validity of the developmental and defect orientations toward conceptualizing mental retardation. Unfortunately, the results do not allow a clear-cut statement of support for either orientation. Study 1 offered the strongest support for developmental theory. Mental age was a much better predictor of children's ability to conserve than was IQ. No retarded-normal differences were found even though the conservation tasks varied in difficulty. Difficulty on these tasks was defined in terms of the usual age at which the various conservations are attained. Similarly, no retarded-normal differences were evident on the less complex tasks of Studies 2 and 3. However, there was some evidence in these latter two studies that retarded children performed more poorly than MA-matched normal children on the more complex tasks. The normal children were better able to eliminate irrelevant dimensions and correctly respond to the relevant dimension in the learning tasks of Study 2, and they showed more efficient use of information in their problem-solving strategies in Study 3.

On the surface, Studies 2 and 3 would appear to support Weir's (1967) hypothesis that differences in the cognitive performance of retarded and normal children will increase as task complexity increases. However, socio-economic background factors were not as well controlled in these studies as they were in Study 1. A number of studies (Gruen & Zigler, 1968; Gruen & Ottinger, 1969; Gruen, Ottinger, & Zigler, 1970) have demonstrated that such factors can have a potent influence on the problem-solving strategies generated by children. Thus, the possibility exists that retarded-normal differences were due to life-history or motivational factors rather than cognitive factors.

Certainly Study 4 demonstrated that non-cognitive factors such as n Achievement and Locus of Control can be significantly related to the learning performance of children. Previous investigations have made similar findings (Gruen & Ottinger, 1969; Ollendick & Gruen, 1971). Thus, the discrepancy in the findings of Study 1 as compared to Studies 2 and 3 with respect to retarded-normal differences may be at least partially due to differences between these groups on non-cognitive subject variables such as these. If the retarded-normal differences in Studies 2 and 3 had been stronger, and if such differences had been found in Study 1, it could be argued that the differences were primarily due to cognitive factors. Such an argument is impossible on the basis of the present data, however.

In fact, as a result of this research effort, the author has come to believe that the controversy between developmental and defect theorists in the mental retardation area may prove as difficult to resolve as the perennial nature-nurture issue. Just as investigators who have attempted to resolve the nature-nurture issue with respect to intelligence have had difficulty specifying "how much" IQ is determined by genetic or environmental factors, investigators concerned with the developmental-defect controversy have found it difficult to determine "how much" of a child's performance on learning or problem-solving tasks is due to cognitive or motivational factors. Anastasi (1958) has suggested to investigators concerned with the nature-nurture issue that they should concentrate their efforts on determining "how" genetic and environmental factors affect intelligence rather than "how much" each contributes. In a similar way, it is suggested here that efforts should be primarily directed at discovering the ways in which cognitive factors and motivational factors influence the behavior of both retarded and normal children rather than trying to specify "how much" each contributes to their behavior.

The same kind of organism-environmental interaction that makes it difficult, if not impossible, to resolve the nature-nurture issue (see Hunt, 1961) makes it difficult to resolve the developmental-defect controversy. Cognitive and motivational factors interact in a multiplicative rather than an additive way to determine children's learning performance. That is, the effect of any given life-history factor that may affect the motivation for learning of a child may be different at one level of cognitive development than another. For example, the effect of a failure experience in a learning situation will undoubtedly have greater impact on the child who is mature enough cognitively to connect his failure at learning to his own efforts (or lack of efforts) than if he is so cognitively immature that he fails to make such a connection. In addition, some variables that are usually thought of as personality-motivational variables (e.g., Locus-of-Control) may in reality be both cognitive and motivational variables at the same time. In short, one is hard pressed to accurately and meaningfully assess the proportion of a child's behavior that is due to cognitive or motivational factors.

A second reason why the developmental-defect controversy may prove impossible to resolve is a methodological one. The design of the experiments included in this report is fairly typical of those designed to resolve the developmental-defect controversy (see Zigler, 1966). The general paradigm is to present normal and retarded children of the same mental age with various comparison tasks. The defect position leads to the expectation of differences in the performance of the two groups due to cognitive differences while the developmental position leads to the prediction of no differences in the performances of the two groups.

With this kind of experimental design, the developmentalist is in the embarrassing position of trying to predict the null hypothesis. He is also stuck with the hardly defensible position of assuming that two groups matched for mental age are matched for level of cognitive development. It has been shown many times that two children who obtain the same MA score may have quite different patterns of abilities (e.g., Magaret & Thompson, 1950).

The defect theorist, on the other hand, not only has to demonstrate clear differences in the performances of the two groups but also has to provide evidence that any differences that are found are not due to motivational or life-history (non-cognitive) factors. It is rare that one can design an experiment where all such factors are controlled so that only cognitive factors are free to determine performance.

It could be argued that the developmental-defect controversy could be reduced simply to the task of determining the relationship of MA and IQ to performance on learning and problem-solving tasks. Thus, a better design than that employed in the present series of studies might be simply to obtain a sample of subjects who vary widely in MA and IQ and then use partial correlation or covariance analyses to determine the extent of the relationship between MA or IQ and the learning performance. This procedure would avoid the statistical pitfall of the "regression to the mean" phenomenon that plagues most "matching" experimental designs, including MA-matching.

It is proposed that future research projects continue the search for both cognitive and motivational influences on the learning performance of children from the whole range of the intellectual continuum. However, their main purpose should not be to attempt to resolve the controversy between developmental and defect theorists. This controversy is impossible to resolve experimentally. Rather, the task should be simply to determine the ways in which various cognitive and motivational factors contribute or detract from the problem-solving performance of children. There is no good evidence that one needs to assume that a different cognitive or motivational system exists for cultural-familially retarded children than that which exists for normal children. (This is not to say that different systems are not necessary for other retarded groups than the cultural-familial.)

Thus, developmental theorists should quit their preoccupation with disproving the hypothesis of defect theorists and get down to the important business of further defining the relationships of various cognitive and motivational factors to cognitive performance. They should also reconsider their penchant for MA-matched paradigms and consider other experimental designs that avoid the statistical pitfalls of such paradigms. This is not to argue that they should avoid looking at the relationship of MA, IQ, or CA to learning performances in children, but simply to state that they should find more powerful ways of determining these relationships.

Defect theorists should quit their penchant to over-generalize and stereotype particular sub-populations of children as "cognitively rigid" (Lewin, 1936) or "having weak memory traces" (Ellis, 1963) or any other such stereotype. The conscientious researcher will look at specific antecedent-consequent relationships in the learning or problem-solving performance of whatever population of children he is using. Likewise, the educator cannot rely on over-generalized stereotypes to help him in teaching individual retarded children. It is only too easy for either the researcher or the educator to rely too heavily on such stereotypes. This is often a way of avoiding the difficult but potentially more fruitful task of identifying specific patterns of abilities, motives, and life-history factors that influence learning. The most difficult task is to identify the ways in which these factors interact to influence learning.

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