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CHAPTER I

INTRODUCTION

Throughout the literature of mental retardation runs the assumption that intellect is directly related to ability to learn abstract material and that mental retardation is coupled with a greater facility with concrete material. Some writers have characterized intellect in terms of ability to deal with abstract symbols. Others have based differential educational programs for the mentally retarded and for the bright upon the assumption of differential facility with concrete and abstract materials. The present study is an attempt to determine the effect of the relative abstractness of the material learned upon the learning rates of bright and retarded students.

Opinions Based on Observation by Educators

Workers in the field of special education tend to find certain characteristics that typify the retarded child and the bright child. These observations provide a fruitful source of hypotheses about the relation between test intelligence and behavior. One limitation to the observational method is that an individual may tend to make certain statements about a retarded group without first determining that this statement could not be made about bright children as well. For example, the statement that retarded students learn concrete material relatively better than they do abstract material may be an accurate observation; however, it cannot be considered a defining characteristic of retardation unless it can be shown that the same statement is not true in regard to bright children.

Below are some attempts by workers in the field of special education to isolate characteristics that are associated with high or low test intelligence.

Ingram (1953, pp. 310-311) suggests that a major difference in the teaching of retarded and normal children is the greater need for concrete learning aids for use by the former in acquiring concepts, together with a need for minimizing abstraction. Although Ingram cites references for many of her statements, no evidence is offered in support of this suggestion.

Although she is in agreement with learning theorists in that "learning takes place in the same way in all individuals, regardless of differing rates of learning ability," (p. 35), Ingram holds with most educators in stressing difficulty with abstract material as a characteristic of the retarded child.

> The mental ability of the slow-learning child at any age is characterized by a slower rate of and a less full total development than that of the average child, and particularly by limitations in abilities having to do with abstract thinking and symbols such as are involved in association, reasoning, and generalization (pp. 33-34).

Hutt and Gibley (1958) reiterate, again without citing evidence, the "characteristic" of moderately retarded children to show relatively greater retardation in abstract learning than they do in concrete learning. "The more concrete the task, the better they function" (p. 105).

Cutts and Moseley (1957, p. 19) list "ability to think abstractly" as one of the characteristics of bright children.

Adams and Torgerson (1956, pp. 83-84) offer as identifying characteristics of bright and dull students a tendency of the dull to be poor in work with abstractions and weakness in making associations readily, as opposed to a tendency of the bright to work with abstractions easily and ease in making associations. They further emphasize the difference in dull and bright students by stating that instruction for dull students must be of a concrete nature, and conversely that concretization be minimized in instruction of the bright.

A curriculum guide distributed to special education teachers in Oklahoma public schools (Oklahoma State Department of Education, 1960) also emphasizes the greater need for concretization of instruction for the retarded.

The 49th Yearbook of the National Society for the Study of Education (1950) characterizes the gifted as being superior to other children in reasoning, generalizing, dealing with abstractions, comprehending meanings, thinking logically, and recognizing relationship. By omission, it must be assumed that superiority with concrete learning is less marked.

Scheifele (1953) has compiled a list of traits that seem to be common to gifted children. Of fourteen intellectual traits of the gifted, she includes six supposedly separate characteristics that have to do with superiority in abstract learning or less interest in practical subjects or manual activities. Her statements are "verified" by referring to other authors who have made similar statements.

Enough correlations between intelligence test scores and school achievement have been calculated to warrant some generalizations about the relationship between measured intellect and achievement in various subjects. A summary of the findings (Sorenson, 1954, pp. 307-308) indicates that in academic subjects (in which abstract symbols are relatively more evident), such as reading, composition, history, arithmetic, English, algebra, and foreign languages, the correlation between I.Q. and performance is generally about .40 to .50.

In industrial subjects (presumably more concrete), such as woodworking, mechanical drawing, sewing, cooking, and in other skill subjects, such as art, drawing, and handwriting, the correlation between mental test score and attainment is only about .20.

In reporting these results, Sorenson predicts that the actual relationships should be higher than indicated because school marks are somewhat inaccurate indices of actual achievement.

The preceding references cited do not constitute an exhaustive bibliography of special education literature, but they are representative in that they offer <u>as fact</u> the assumption of greater disparity between concrete and abstract learning in the case of retarded students.

To make such programs of differential treatment of retarded and gifted not only scientifically valid but also economically feasible, it is essential that the assumption of differential facility with concrete and abstract learning by retarded and gifted students be scientifically established or repudiated in a controlled test situation.

Expectations Derived from Intelligence Test Performance

The assumed relationship between intelligence and greater facility with abstract learning is in part derived from observed performance on intelligence tests, of which the Stanford-Binet Scales (Terman and Merrill, 1937) are perhaps the best-known examples. In such scales, an intelligence quotient (I.Q.) is derived for an individual by dividing his "mental age" (MA) by his "chronological age" (CA). The chronological age is determined by the number of years and months that have elapsed since the birth of the individual. The mental age is determined by the average performance of individuals of a given chronological age. A particular item is placed at an age level that would permit a normal distribution of I.Q. scores with a mean of 100 (i.e., mental age equal to chronological age), and, in the case of the Binet Scales, a standard deviation of approximately sixteen I.Q. points at each age level.

A *post hoc* examination of successes with test items leads to an observation that concrete items such as identifying parts of the body of a paper doll or recognizing pictures of familiar objects such as a shoe, clock, chair, or bed (Terman and Merrill, 1937, pp. 194-195) chronologically preceded more abstract items such as memory for designs (ibid., 248-249) or ability to learn codes (ibid., 280-281).

The thoroughness of the normative studies of individual psychometric tests is not being questioned; however, the deductions derived from analysis of the results of such normative studies is legitimately open to further scrutiny. It is not the purpose of the present study to validate the placing of items requiring facility with concrete symbols (pictures of "real" objects) prior to items requiring facility with abstract symbols ("abstract" designs or codes). However, there may be factors other than abstraction involved in item difficulty. The purpose of the present study is to determine whether the observed relationships between success with certain types of items at different chronological ages justifies differences in methods of teaching bright and dull students. Essentially, the question is whether the intellect of an individual is a significant factor in his relative rates of learning concrete and abstract materials.

Constructors of intelligence tests must formulate some definition of what they purport to measure or assess. The variety of definitions of intelligence have been classified into three categories according to the major emphasis of the authors (Freeman, 1955). Intelligence may be defined as (1) adjustment to one's total environment or to limited aspects thereof, or (2) ability to learn, or (3) ability to carry on abstract thinking. Alfred Binet's conception of intelligence belongs largely in the third category, and his early work laid the foundation formmuch of the recent construction of intelligence tests.

A statistical analysis of the 1937 revision of the Stanford-Binet Scales revealed a common factor operating at all levels so as to cause high intercorrelations of test items (McNemar, 1942). This finding of a general factor is consistent with Binet's early contention that he was testing general intelligence.

Item analyses of the Stanford-Binet Scales show a different pattern of passes and failures for bright children and for normal or dull (Baldwin, 1948; Magaret and Thompson, 1950). The items favoring the bright and superior children include the verbal and numerical, utilizing symbols and abstractions.

It is consistent with a general factor or global theory of intelligence that intelligent behavior is also involved in dealing with semi-concrete materials. Terman and associates (1942) have devised a test consisting of only a single type of item throughout. Each item consists of five pictured objects, four of which "belong" on the basis of some common relationship, and a fifth item which does not "belong". For example, item one has a cup, a glass, a ball, a pitcher, and a mug. The subject is to mark the ball as the nonbelonging item as all the others are containers for liquids.

The authors state that their scale is constructed to measure the ability to recognize and utilize relationships among pictorial symbols rather than among verbal symbols (Terman *et al.*, 1942). Apparently it is consistent with a global theory of intelligence that high intelligence is positively related to ability to deal with semi-concrete material just as it is related to ability to deal with abstract material.

E. L. Thorndike has divided intelligent activity into three types: (1) social intelligence, or ability to deal with people; (2) concrete intelligence, or ability to deal with things, as in skilled trades or appliances of technology; (3) abstract intelligence, or ability to deal with verbal and mathematical symbols. Thorndike's is essentially an atomistic theory of intelligence, in that it attempts to analyze "intelligence" into several areas of functioning, or elements of ability (Freeman, 1955, pp. 69-72).

Opposed to Thorndike's milti-factor theory of intelligence is Spearman's two-factor theory. Spearman (1927) postulates a <u>general factor</u> (<u>g</u>) common to all mental activity. This factor is characterized as mental energy analagous to physical energy in the physical sciences. It can be observed and measured only through its specific manifestation in situations such as psychological tests. Spearman postulated the <u>g</u> factor to explain correlations among diverse subtests such as analogies, completion, opposites, etc.

To explain the imperfect intercorrelations of different mental activities, Spearman postulated specific factors (<u>s</u> factors), each of which is specific to a particular type of activity. Subtests that correlate highly with each other but less highly with general functioning are said to possess a "group factor".

Thurstone's (1943) tests of primary mental abilities are based on a theory that intelligent activity is neither an expression of innumerable specific factors as Thorndike believed, nor an expression of an all-pervasive general factor as Spearman claimed, but that certain mental operations have in common a "primary" factor giving them unity and differentiating them from other mental operations. Thurstone identified six "primary" factors: number, verbal, space, word fluency, reasoning, and rote memory. In practice, the "primary" abilities proved not to be functionally independent. This positive correlation between factors caused Thurstone to postulate a "second-order general factor" similar to, but less significant than, Spearman's g factor.

Stoddard offers an all-inclusive definition of intelligence as "the ability to undertake activities that are characterized by (1) difficulty, (2) complexity, (3) abstractness, (4) economy, (5) adaptiveness to a goal, (6) social value, and (7) the emergence of originals, and to maintain such activities under conditions that demand a concentration of energy and a resistence to emotional forces" (Stoddard, 1943, p. 4). For Stoddard, "abstractness", or operating with symbols "lies at the heart of intelligence as defined."

One major test constructor defines intelligence as "the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment" (Wechsler, 1944, p.3).

Wechsler (1952) cites ratios of the range of variability on a large number of traits that demonstrate that" . . . relatively 'simple' traits usually have much smaller total range ratios than 'complex' ones" (p. 61). The total range ratio for height is less than for body weight; the range ratio for simple learning (Form Board) is only 2.42:1 whereas the range ratio for hard learning (substitution) is 3.87:1. These range ratios were derived by obtaining the scores of the second and 999th ranked person in a group of one thousand (i.e., eliminating the upper .001 and the lower .001), and making a ratio of the higher to the lower score. According to Wechsler, it may be expected that there is greater variability in the learning rates for abstract or symbolic material than in the learning rates for semi-concrete or pictorial material because the abstract symbols are meaningful only in relation to other symbols whereas the pictures represent specific objects.

Wechsler (1952)hypothesizes a "configurational theory of human abilities" which attempts to reconcile both quantitative and qualitative evaluations of mental variation.

> The mental defective is not only a person who has less of the same thing (e.g., intellectual ability) than a person of "dull normal" intelligence, but one who shows a type of behavior which appears to be qualitatively different. The same may be said with regard to differences between a moron and an imbecile, etc. . . . and these differences in "looks" and "behavior" can be explained by assuming that human intelligence when passing certain points takes on new configurations which for phenomenological reasons we find it convenient to recognize as different totalities (Wechsler, 1952, pp. 133-134).

> . . . Genius and degeneration are but two such critical points, of special interest because of their practical and social importance, but only illustrating a general phenomenon or principle that quantitative variations may give rise to qualitative differences. . . . What the actual mechanism of the transformation may be is at present hard to conjecture, but in purely psychological terms, one might say that, as a result of the change, a new configuration is produced (Wechsler, 1952, pp. 134-135).

Wechsler believes that the new quality or new organization "differs from the preceding only by the fact that it has more or less of the same kind of stuff differently arranged" (Wechsler, 1952, p. 136).

The "mental age" concept has been characterized as somewhat misleading because of these qualitative differences in the intellectual functiioning of bright and retarded children who achieve the same mental age on an intelligence test (Goodenough and Tyler, 1959, p. 295).

Guilford (1961), in formulating a cubicle model representing the structure of intellect, differentiates three different aspects to be considered in analyzing intellectual functioning: contents, products and operations. Should his method of structuring intellect gain wide acceptance, it may be worthwhile to translate the present study into his proposed terms.

On the basis of classification according to the contents involved, Guilford differentiates between figural, symbolic, semantic, and behavorial content. The figural content is of the same type as the content that has been labeled in this study as "concrete", i.e., material that represents only what is perceived. The material that has been labeled "abstract" in this study would be classified by Guilford as symbolic.

The classification according to products include units, classes, relations, systems, transformations, and implications. In the present study we are concerned with the relations between the two figures that are paired. The relation is that of contiguous presentation.

In Guilford's third classification, according to operation, there are five major groups of intellectual abilities: the factors of cognition, memory, convergent thinking, divergent thinking, and evaluation. In the present study we are concerned with memory. The present study then, being concerned with the formation of associations between paired units, represents abilities to remember (for the short time required to complete the tasks) relationships involving two kinds of contents, figural, and symbolic.

Empirical Studies

A unified theory of learning would seemingly require that the same processes be involved for both retarded and bright individuals. In fact, much of our present learning theory is based upon studies of the learning behavior of species below the human in the phylo-genetic scale (Deese, 1952; Hull, 1943; Skinner, 1938).

Learning theorists have not generally been concerned with the ways in which bright and retarded individuals differ in their learning rates for different types of materials. Learning theorists seemingly agree that" . . . it is of no particular consequence what an organism learns: the basic question is how?" (Mowrer, 1960, p. 9).

Kirk (1950) has pointed out that there has been little research directed toward the problems encountered in the education of exceptional children. Kirk offers the following reasons for the paucity of research in this area:

> 1. The original work in this field was spearheaded by promoters and humanitarians and not by scientists. Funds were made available for services rather than for research. . . .
> 2. Custodial institutions and special schools established for the care and training of exceptional children have not usually been equipped for research . . . .
> 3. Relatively few research foundations direct their efforts toward the study of the education of exceptional children.
> 4. Universities . . . have been slow to recognize the need for research in the education of exceptional children in general and but few of them even now have a specialized staff to design and organize research projects and to train specialists in this field . . . . Universities have relied upon the basic sciences to furnish data but have not appointed staffs to spearhead the program or to draw upon facts from the basic sciences.
> 5. Field personnel, such as state or city directors of special education, have more than a full-time job carrying on the service functions of their departments and have had little time for research activities (Kirk, 1950, p. 321).

McGeoch (1942) cites some early studies of the relation between learning and intelligence. He reports that almost without exception the correlation is positive between learning rate and intelligence.

H. E. Garrett (1928) found that paired associates learning rates and Thorndike Examination score had a correlation coefficient of .23, digit-symbol substitution correlated with Thorndike score .09, Turkish-English vocabulary was correlated with Thorndike score .37, and code learning had a .31 correlation with the Thorndike score. Meaningfulness of the material seemed to be an important determinant of its relation to test intelligence.

F. T. Wilson (1928) found that learning a multiplication table and learning to recognize shorthand characters clearly distinguished bright from dull students. He found no significant differences in performance on motor tasks. Wilson concluded that tasks distinguished the bright from the dull in proportion as these tasks require less muscular movement.

L. S. Hollingworth and M. V. Cobb (1928) studied two groups with I.Q. scores clustering around 146 and 165. They found that the groups differed most in getting meaning from words, paragraphs and sentences. There was less difference in ability to perform arithmetical operations. They conclude that the difference increases as the number of elements or associations involved in the material increases.

From his survey of the literature, McGeoch concludes that there are at least five dimensions on which learning materials are distributed and in terms of which relations between intelligence and learning are influenced. These dimensions are meaning, amount of symbolic process, difficulty or complexity, amount of discovery required, and overt muscular response. McGeoch states that correlations between MA and learning are usually higher than those between CA and learning.

In a typical memorization task (anticipating ten simple nouns on a memory drum), Ellis and associates (1960) found significant differences in learning rate between mentally subnormal (I.Q. 40 to 89)), normal (I.Q. 90 to 109), and bright (I.Q. 110 to 139) groups. On a maze-learning task, there was no significant difference between the performance of normal and bright subjects, but the subnormal subjects required a significantly greater number of trials. Subjects were from public schools, an institution for delinquent girls and an institution for mental defectives. The experimenters cite factors pertaining to task difficulty, cultural difference between samples, and use of different intelligent tests as weaknesses in the experiment.

Reynolds and Stacey (1955) compared defectives (I.Q. levels 50-59, 60-69, and 70-79) and normals (I.Q. 90-110) on a mirror drawing task. The subnormals were inferior to the normals in speed scores, and performance of the defectives was approximately proportional to I.Q. level. Performance was more variable for those in the lower I.Q. groups than for the normals.

Wilson (1931) concludes that the findings of psychological research support the hypothesis that intellectually bright and dull children learn by the same processes. The dull child can solve many of the same kinds of problems as his brighter peers, but many make more errors and require more time to reach a given criterion of performance. The dull and the young may make more errors, but the older and the brighter child also make errors, and they are the same kind of errors. In the study cited (Wilson, 1931) every individual in each category (dull, bright, old, young) made learning progress along the same lines on a problem that could be broken down into observable steps.

The educational records of gifted children (a group of one thousand, five hundred subjects with I.Q. 135-200 on the Stanford-Binet scale or the Terman Group Test, with average I.Q. 152) indicates that some types of school activities are more closely related to measured intelligence than are other activities. The gifted students showed greater superiority over a control group of average children in the "abstract subjects" and relatively little superiority in penmanship, spelling, and routine arithmetical computations. Both bright and average groups showed an unevenness in achievement, but there was a difference in direction; whereas the gifted are at their best in "thought" subjects, average children are at their best in subjects that make least demands upon concept manipulation (Terman and Oden, 1947).

There is no definite correlation between age and stages of concept formation. Bright children may develop an adequate concept earlier than other children, but they apparently go through comparable stages in achieving it (Dennis, 1942).

Eisman (1958) studied the associative learning rates of bright, average, and retarded children with a series of paired pictures. She used only seven pairs of pictures and informed each subject as to his success with each pair by verbally acknowledging correct responses and by following each test card with the stimulus card which showed what the correct response should have been. Using this method, she did not find significant differences in performance by the three groups, although performance was more variable for those in the retarded group. Eisman suggests the possibility that her task was too simple to reveal any differences. Inspection of her data also reveals that subjects in the different groups were not closely matched in terms of age. The oldest subject in the retarded group was 17 years, 2 months old, while the oldest subject in the bright group was 14 years, 4 months old. There was also a difference in the ethnic composition of the bright group in that it was composed entirely of Anglo-Americans while the average and retarded groups were predominantly Mexican or Negro.

Eisman's use of pictorial learning material is illustrative of the notion that semi-concrete materials are more "fair" to retarded children, because of their limited ability to deal with verbal and numerical symbols, and that learning pictorial material is analagous to learning within the classroom. It is of course true that learning rates of two groups cannot sensibly be compared when one group is learning the names of the two stimuli at the same time that it is learning to associate the two stimuli. If the retarded child's limited ability to learn materials involving verbal and numerical symbols is only a function of less familiarity with such materials, then it may be acceptable to use more familiar materials, such as pictorial materials, and generalize to the learning rates of retarded children for any other type of familiar material. However, if, as many psychologists believe, ability to deal with symbols is a higher form of intellectual activity than is the ability to deal with concrete objects, it may be that there are different processes involved in the learning of concrete and abstract materials, and that data about learning rates for concrete materials cannot justifiably be generalized either to learning rates for abstract, symbolic materials or to ability to learn the type of material considered of value within the school curriculum.

Dealing with verbal and numerical symbols is considered by many psychologists (Freeman, 1955, p. 268) to be a higher form of mental activity than dealing with concrete objects because such symbolic behavior permits the individual to go beyond the immediate concrete situation. Use of language and number permit more complex and subtle mental operations than are possible within the reality limited by immediately available concrete objects.

The concept of concrete and abstract representing different "levels" of mental activity, in the sense that abstract involves cortical functioning of a higher level, receives some support in evidence that schizophrenics who show marked loss of ability to function well in abstract tests also tend to show physiological signs of lessened central nervous system control over the sympathetic nervous system. An example of this lessened control is a failure of the blood pressure to rise under stress.

Meadow and Funkenstein (1952) theorize that a loss of abstraction ability represents a "release" of the sympathetic nervous system from higher control:

> . . . the theory is advanced that an intact functional capacity of the cerebral cortex is a prerequisite both for abstract thinking and for proper "firing" of the autonomic nervous system. When association or reverbation pathways are inadequate, thinking is concrete and the autonomic nervous system is not "fired off"; it is released from higher control (p. 147).

No deductions are made in their study as to whether the implied cortical malfunctioning is primary, or whether it is secondary to change elsewhere in the central nervous system, autonomic nervous system, or adrenal cortex.

In this chapter, literature from the fields of special education, intelligence testing, and experimental psychology as it relates learning theory to intellect have been surveyed. There is general agreement that the type of material learned is an important factor in the differential effect of intellect upon the learning rate.

The relationship between test intelligence and learning rates for concrete and abstract materials has been inferred from observed classroom performance, from intelligence test items passed and failed by bright and retarded children, and from learning experiments in which the learning rates of bright and retarded subjects were obtained for different types of tasks. Tasks more similar to "academic" school subjects are relatively more difficult for retarded subjects; tasks of the motor or manipulation variety show less marked difference between bright and retarded subjects. The tasks compared tend to differ in respect to the response required of the subject and the number of associations required as well as in respect to the abstractness of the material learned. In order to make a more definite statement as to the effect of the abstractness or concreteness of the material learned upon the learning rates of bright and retarded subjects, the tasks must be similar in all respects other than the relative abstractness of the stimulus items. Such is the purpose of the present study. The proposed tests of hypotheses about the relation between test intelligence and learning rates for different types of items will be more fully explained in the two following chapters.

CHAPTER II

STATEMENT OF THE PROBLEM

The present study is an attempt to determine the effect of the type of material upon the learning rates of bright and retarded students. The rate of learning can be defined in terms of either the number of errors occurring before the material is learned to one perfect performance or the number of trials required to reach one perfect performance. Another important factor in learning is the experienced difficulty. In the present study, all three measures will be used to assess the relative difficulty of semi-concrete and abstract materials for bright and retarded students.

The present study is limited to associative learning of pairs of semi-concrete items in one task (Set C) and pairs of abstract items in another task (Set A). This learning by contiguity is one of the most pervasive of all psychological laws. According to the principle of association by contiguity, when two or more items are associated in time or place, the recall of one facilitates recall of the other. Instances of this type of association include the learning of the alphabet, of number sequences, of associating first and last names, of history dates and events, of English and foreign words, and of recalling prices of articles.

In order to study learning by contiguity, it is necessary to control for association by similarity. Fox example, it may be relatively easier to associate dog and cat than it would be to associate frog and shoe. While learning associations by similarity is an important aspect of human behavior, it is more difficult to control in a laboratory experiment because of the great difference in previous associations learned by the different subjects before the beginning of the experiment. For this reason, an attempt was made to eliminate items where associations by similarity would be highly probable. By omitting these items where previous learning would affect the association, it was hoped that the learning process itself could be more readily observed. In this, the present study differs from intelligence testing where the response is more likely to be related to previous experiences.

The present study is concerned primarily with the type of symoblic material most frequently encountered in academic subjects: letters of the alphabet and arabic numerals. Such symbols are not only of practical value in that they provide the basis for verbal and numerical performance, but they also are of significance as philosophical entities in that they stand in defined relations to other letters and numbers making possible operations in abstraction permitting a system of conceptions related together as conceptions (Dewey, 1939, p. 876).

Hypotheses

The hypotheses in this study concern both measured learning rates and experienced difficulty as expressed by the learner.

If intellect is not an important variable in differential ability to learn concrete and abstract materials, bright and retarded students should have the same ratios for learning rates of concrete to abstract materials. Furthermore, there should be no difference in the expressed feeling of greater difficulty with abstract materials by either bright or retarded students. Further tests will be made of the significance of any difference in performance by bright and retarded students on each test.

The following null hypotheses are to be tested:

1. $\underline{H_o}$: there is no difference in the learning rates of bright and retarded students on semi-concrete materials. $\underline{H_1}$: the bright students will require fewer trials and make fewer errors in learning Set C.

2. $\underline{H_o}$: there is no difference in the learning rates of bright and retarded students on abstract materials. $\underline{H_2}$: the bright students will require fewer trials and make fewer errors in learning Set A.

3. $\underline{H_o}$: there is no difference in the learning rates of retarded students on seim-concrete materials and abstract materials. $\underline{H_3}$: the retarded students will require fewer trials and make fewer errors in learning Set C than they will in learning Set A.

4. $\underline{H_o}$: there is no difference in the learning rates of bright students on semi-concrete materials and abstract materials. $\underline{H_4}$: the bright students will require fewer trials and make fewer errors in learning Set C than they will in learning Set A.

5. $\underline{H_o}$: there is no difference in the ratios of semi-concrete to abstract learning rates of bright and retarded students. $\underline{H_5}$: the ratio

of Set C/Set A trials and the ratio of Set C/Set A errors will be higher for the bright group than for the retarded group.

6. $\underline{H_o}$: there is no difference in frequency of expressed greater difficulty with abstract materials by bright and retarded students. $\underline{H_6}$: the retarded students will more frequently express greater difficulty with abstract materials.

7. $\underline{H_o}$: there is no difference in frequency of expressed preference for learning concrete materials by bright and retarded students. $\underline{H_7}$: there is a greater preference for learning concrete materials expressed by retarded students.

CHAPTER III

PROCEDURE OF THE STUDY

The Pilot Study

Semi-concrete Materials (Set C)

An associative learning task was chosen for the pilot study because associative learning is perhaps the most commonly used type of learning in the public schools. Because of the difficulty involved in presenting time exposure of concrete objects, the materials used in the semi-concrete test (Set C) consisted of pictures of real objects. The paired associates method was used. In this method, subjects were individually administered a set of cards, each card having two pictures printed on it. Each card in this set was exposed three seconds. After an interval of ten seconds, a second set of cards was presented at five second intervals. The longer time interval on the second series was to give the subject time to respond. This second set of cards had only the left hand picture printed, with nothing printed in the space corresponding to the right hand picture of the first set. The subject was instructed to tell what was missing on the right hand side of the card. One trial consisted of a presentation of the learning cards and the test cards. A record was kept of trials and errors but the subject was given no indication as to the correctness of a response. Each subject continued until he achieved one perfect performance.

An important part of the pilot study was the determination of the length of the test, that is, the number of pairs to be in a series. The length desired was the minimum number of pairs which would differentiate between various grade levels with respect to learning rate and retention. Lists of eight, twelve, sixteen, twenty, and twenty-four pairs were tested.

A list of twelve pairs was first given to groups of twelve first, twelve fourth, and twelve eighth graders. Using chi-square as the test of significance, the twelve-pair list was found to discriminate between the three groups with respect to learning rate and retention. The differences were significant at the .05 per cent level of significance.

The list was then lengthened to sixteen, twenty, and twenty-four pairs in order to see what effect test length had on learning and retention. Forty subjects were tested with the sixteen-pair list, forty subjects with the twenty-pair list, and thirty subjects with the twenty-four-pair list. None of the three increased test lengths was found to be more discriminative than the twelve-pair list. An eight-pair list was then tried on thirty subjects to see if a shorter list would be as discriminative as the twelve-pair list. It was found not to be. Apparently, the task was so easy for all grade levels that it did not discriminate between them. Eisman (1958) used seven pairs and criticized her study in that her lists may not have been long enough to be discriminative. The twelve-pair list proved to be of optimum length for easy administration and discriminability in the pilot study.

Certain criteria were set up for the selection of the pictures.

The criteria were: (1) the pictures must be simple, outline drawings of common objects; (2) the words represented by the pictures must be one-syllable nouns; (3) the pictures must be immediately recognizabel; (4) the pictures must be readily and consistently identifiable; that is, if a picture of a horse was sometimes called "pony" and sometimes "horse", the picture was eliminated; and (5) pictures must not be obviously potentially affect arousing, for example, a picture of a gun or of a snake. In order to insure immediate recognition and consistent identification, the pictures were shown to groups of seventy-five kindergarten children and forty fourth-grade children. Pictures which did not meet the above criteria were eliminated.

During the testing to determine test length, serial effects were noted in the learning curves of some groups. That is, the first and last pairs of the list tended to be learned first, with the middle pairs being learned last. This was evidence of the well-known phenomenon which takes place when items are learned serially. It was known that if the learning curves could be flattened so that the end-pairs of the lists were not learned more quickly than the middle-pairs, the serial effects would be controlled and a random presentation of the lists would be unnecessary. Therefore, one hundred twelve students were then tested using various arrangements of the pairs until the learning curves became flat with certain arrangements. It was desired to keep the arrangement of the pairs constant, since certain random orders might be more difficult to learn than others; and an additional variable would then be introduced. A random presentation of pairs could not be kept constant from subject to subject since the subjects would vary with respect to the number of trials needed to reach the learning criterion.

Abstract Materials (Set A)

For the purpose of testing hypotheses about relative rates of learning abstract and semi-concrete materials, it was necessary to develop a learning task comparable to the one described above, except that the items to be matched must be more abstract. Cards were prepared with pairs of common abstract symbols such as the symbols for dollar, cents, division, multiplication, equal, ampersand, square root, circle, triangle, and square. Preliminary trials with seventeen bright and seventeen retarded junior high school students revealed that there was great variability in familiarity with the names of the symbols and with an understanding of their meaning. It was necessary to eliminate all of this series of symbols.

In order to find abstract, symbolic material which the retarded group could identify, it was necessary to use the verbal and numerical symbols (letters of the alphabet and arabic numerals) to which they had been exposed for several years.

As a part of a regular English assignment in classes for retarded children, tests were given on the recognition of numerals and letters. It was found that most of the retarded students, even poor readers and those who had difficulty in mathematics, could readily identify the numerals and letters by name and correctly position them serially. Although there were some who did make errors, it was decided to use these symbols and eliminate as subjects any student who had made one or more incorrect identification in this preliminary English class assignment.

Matching of the numerals with letters was randomized by having a child select from a box the folded papers on which letters had been written and from another box the folded papers on which numerals had been written. Items were placed together in the order they were randomly selected. Twelve series of numerals and letters were matched to provide an abstract task comparable in length to the semi-concrete task. The items were presented to the subjects in the same order, according to the initial random selection.

In order to eliminate items in which bright students may be expected to have an advantage of association by similarity, one pair of items, 5 and V were not retained although they had been drawn together as a pair. The two rejected items were returned to the boxes and redrawn. The letters I and O were eliminated because of their similarity to the numerals one and zero.

Subjects

The subjects in this study are forty students at Jackson Junior High School in Oklahoma City, Oklahoma. The subjects are divided into Group R (low I.Q.) and Group B (high I.Q.).

Group R consists of ten boys and ten girls who received an I.Q. of 80 or lower on an individual intelligence test. Subjects in Group R were tentatively selected from that part of the school population that received an I.Q. of 80 or lower on the California Mental Maturity Scale, a group intelligence test administered by school counselors, and who could be matched by sex and age within three months with subjects who scored 119 or higher on the group test. The tentative Group R subjects were then administered Form L of the revised Stanford-Binet Intellig- ence Scale. I.Q.'s reported for retarded subjects are Binet I.Q. scores. Group R ranged in I.Q. from 59 to 80 with a median score of 69.

Group B consists of ten boys and ten girls who received an I.Q. of 119 or higher on the California Mental Maturity Scale, a group intellig- ence test administered by school counselors, and who could be matched with a subject in Group R by sex and by age within three months. Group B ranged in I.Q. from 119 to 143 with a median I.Q. of 127.

The age of subjects in Group R ranged from twelve years, three months to fifteen years, one month, with a mean age of thirteen years, nine months.

The age of subjects in Group B ranged from twelve years, four months to fifteen years, four months, with a mean age of thirteen years, nine months.

All subjects in Group R were enrolled in classes for slow learners or in special classes for mentally retarded students. All subjects in Group B were enrolled in accelerated classes. Because promotion prac- tices do not necessarily indicate similar achievements in special classes and in regular or accelerated classes, no effort was made to match the groups in regard to school grade.

Materials and Procedure

Two sets of learning materials were used to obtain abstract and semi-concrete learning rates. A short questionnaire was orally admin- istered at the end of the testing session to determine the subjects' feelings about the difficulty of the two types of materials.

Test materials consisted of two series of paired items. Each series, Set A and Set C, consisted of two booklets. Each booklet contained sixteen five-inch by eight-inch cardboard cards bound together by a flexible plastic spiral band. Booklet One of each series contained thirteen cards on each of which there was one pair of stimulus items and three blank cards serving as front, back, and blank page between sample card and stimuli cards. One pair served as a sample card; the other twelve pairs were the stimuli cards. Booklet Two of each series contained thirteen cards on each of which appeared the left hand stimulus item, with nothing printed in the space corresponding to the right hand item of the stimulus card. The first stimulus card served as a sample card for instructional purposes and the other twelve constituted the learning task. Three blank cards were included in these booklets also.

The selection of the items used, the matching of pairs of items, and the order of the pairs in the test series have been discussed in the preceding section, The Pilot Study.

Each subject was tested individually in quiet, well-ventilated, and well-lighted rooms. Each subject was brought to the testing room by an office aide. The examiner assured each subject that his performance on the test would be held confidential and that the testing was not related to academic testing. The subject was seated to the left of the examiner and at a right angle to the examiner at the end of a table.

The following instructions were given to each subject for his first series:

> There are several cards in this booklet. Each card has two pictures on it (or, a number and a letter if Set A was presented first). Look at both pictures on each card carefully. (Examiner then shows the sample card with only the left hand stimulus item of the pair.) After I have shown you the cards with two pictures (or a numeral and letter) shown together, I will show you another set of cards like these. You are to tell me what picture was shown with this picture. What you are supposed to do is to remember which two pictures go together. Be sure to look at both pictures so that you can remember what pictures go together.

The twelve pairs of items in Booklet One were presented visually to each subject at the rate of one card every three seconds. After an interval of ten seconds, the twelve cards of Booklet Two were presented at five second intervals. This second set of cards had only the left hand picture printed, with nothing printed in the space corresponding to the right hand picture of the first set. One trial consisted of a presentation of the twelve learning cards and the twelve test cards. A record was kept of trials and errors but the subject was given no indication as to the correctness of a response. Each subject continued until he achieved one perfect performance.

The following pairs of pictures, drawn in black ink on white five inch by eight inch cards, comprise Set C:

Tent - Brush
Bus - Cow
Horn - Boat
Glass - Dog
Feet - Key
Frog - Broom
Cat - Bed
Star - Train
Moon - Door
Ball - Rake
Sled - Bone
Spoon - Slide

The materials used in the abstract learning test (Set A) consisted of arabic numerals and capital letters printed on five by eight inch cards, with a numeral on the left hand side and a letter on the right hand side of the learning set. The letter was omitted from the cards in the testing set.

The following pairs of items, drawn 1 3/8 inches high in black ink on the cards, comprise Set A:

4 - Y
8 - H
3 - C
9 - B
10 - P
2 - Q
5 - K
1 - N
13 - L
12 - W
7 - X
6 - V

Order of presenting Sets A and C to the subjects in the bright group and the retarded group was counter-balanced to off-set any effect of inhibition or transfer.

After each subject had learned Set A and Set C to the criterion of one perfect performance on each Set, a questionnaire consisting of three questions presented orally was administered to determine the subject's feelings of difficulty with the tasks:

1. Which set seemed more difficult while you were taking it?
2. On which set do you feel you made a better score?
3. If you had to spend a long time in studying one type of material, which type would you rather learn?

The Obtained Data

The following data were obtained for each of the forty subjects participating in the study: name of child, chronological age, intelligence quotient, presenting order of Sets A and C, response to each test item, total number of trials required by subject to reach criterion on Set A and Set C, total number of errors made by each subject in reaching the criterion on Set A and Set C, response to each of the three questionnaire items, and accuracy of estimate as to each subject's best performance.

CHAPTER IV

RESULTS AND DISCUSSION

Two groups of twenty students each were used in this study to compare the learning rates of bright and retarded students on paired-associative learning tasks with two types of stimulus materials, semi-concrete and abstract. The bright group (GroupB) ranged in I.Q. from 119 to 143. The retarded group (Group R) ranged in I.Q. from 53 to 80. Subjects in the two groups were matched by sex and by age within three months. The retarded group ranged in age from twelve years, three months to fifteen years, one month, with a mean age of thirteen years, nine months. The bright group ranged in age from twelve years, four months to fifteen years, four months, with a mean age of thirteen years, nine months.

The semi-concrete learning task consisted of twelve pairs of outline drawings of real objects; the abstract learning task consisted of twelve pairs of matched numerals and letters. A short questionnaire was administered orally to each subject to determine his subjective estimate of the relative difficulty and preference for the semi-concrete and abstract tasks.

Seven hypotheses were tested to determine whether the two groups differed in performance on each of the tasks, whether each group differed in performance on the two tasks, whether the two groups differed in the relative facility with the two tasks in terms of a ratio of concrete to abstract, whether the two groups differed in frequency of expressed greater difficulty with abstract material and whether the two groups differed in frequency of expressed preference for concrete material. In this study the required level of statistical significance was set at .05.

The data in Table 1 (page 35) show the number of trials required for each subject to reach the criterion of one perfect performance on each of the two learning tests and the data in Table 2 (page 36) show the number of errors made by each subject on each of the tests. It is assumed that the trials scores indicate at least an ordinal measure of the difficulty of learning each set of materials. The errors scores are included as an additional indicator of difficulty, or at least as an ordinal measure of efficiency of learning. Lower trials scores indicate that an individual learned the material faster (with fewer presentations). Lower error scores indicate that an individual learned the material more efficiently, that is, he made fewer mistakes in naming the item matched with a presented item.

Preliminary inspection of Tables 1 and 2 shows a trend toward superior performance by the bright subjects on both semi-concrete (pictures) and abstract (letters and numerals) learning tests. This trend is evident whether the comparison is made on the basis of trial scores or errors scores, and whether the comparison is between means or medians.

TABLE 1

NUMBER OF TRIALS OF RETARDED AND BRIGHT SUBJECTS ON SETS C AND A

Subject Pair	Retarded Group Set C	Set A	Bright Group Set C	Set A
a	14	16	2	5
b	3	8	5	11
c	8	14	4	3
d	11	18	3	3
e	8	12	6	4
f	4	12	3	5
g	13	14	4	4
h	4	5	2	3
i	7	10	2	6
j	10	11	5	3
k	8	17	5	5
l	4	5	3	3
m	11	17	6	6
n	5	3	7	10
o	5	8	4	4
p	15	14	8	6
q	3	5	3	7
r	16	10	4	3
s	9	4	3	4
t	9	17	6	7
Total	167	220	85	102
Mean	8.4	11.0	4.3	5.1
Median	8	11.5	4	4.5
Range	3-16	3-18	2-8	3-11

However, the range of scores shows that there is some overlap in the performance of the two groups.

The bright subjects required from two to eight trials to learn Set C (pictures), with a mean of 4.3 and a median of four trials. The re-

TABLE 2

NUMBER OF ERRORS MADE BY RETARDED AND BRIGHT SUBJECTS ON SETS C AND A

Subject Pair	Retarded Group Set C	Set A	Bright Group Set C	Set A
a	58	62	3	24
b	8	42	19	46
c	26	63	13	10
d	54	127	6	8
e	39	63	24	10
f	17	77	11	20
g	46	53	9	11
h	19	15	1	17
i	33	53	6	33
j	47	73	19	13
k	44	140	16	28
l	16	27	8	5
m	63	72	34	27
n	8	15	41	45
o	26	43	13	9
p	71	92	35	27
q	14	15	7	34
r	40	36	14	8
s	58	24	11	14
t	56	124	31	35
Total	743	1216	321	424
Mean	37.2	60.8	16.1	21.2
Median	39.5	57.5	13	18.5
Range	8-71	15-140	1-41	5-46

tarded subjects learned the same set in from three to sixteen trials, with mean and median of 8.4 and eight.

In learning Set C, the bright subjects made from one to forty-one errors, while the retarded subjects made from eight to seventy-one errors. The bright group had a mean of 16.1 and a median of thirteen errors compared to the retarded group's mean of 37.2 and median of 39.5 errors.

Two of the twenty subjects in the retarded group required fewer trials to learn Set C than the median (four) of the bright group. Another three retarded subjects learned Set C in four trials. Therefore, despite any general trend, five out of twenty (or one-fourth of the retarded subjects learned the picture material as quickly as did the median bright subject. Two of the retarded subjects made fewer than the median number of errors (thirteen) made by the bright group in learning Set C.

None of the bright subjects required more trials, and only one required as many trials as the retarded group's median of eight trials to learn Set C to the criterion of one perfect performance. Also, only one of the bright subjects made more errors than the retarded group's median of 39.5 errors on Set C.

None of the bright subjects required more trials than the retarded group's median of 11.5 to learn the paris of numerals and letters (Set A.) Nor did any of the bright subjects have higher error scores on Set A than the retarded group's median of 57.5.

Two retarded subjects required fewer trials and three made fewer errors in learning Set A than did the median subject in the bright group.

Prior to testing the specific hypotheses of the study, the Friedman two-way analysis of variance was chosen to determine whether there is any statistically significant difference in the rank totals for the two conditions of intellect (retarded and bright) and the two treatments by type of material learned (Set C and Set A). If no significant difference exists between the four rank totals, this would indicate that the first four null hypotheses are tenable. The trials scores for the four conditions are shown in Table 3 (page 39.)

Because the trials and errors scores probably do not constitute an interval measure of learning, but are at least an ordinal measure, this non-parametric two-way analysis is appropriate as more than two sets of related data are being analyzed, the Friedman technique is appropriate. The level of significance chosen is .05. N equals 20, the number of subjects in each group.

The statistic employed is χ_r^2 (Siegel, 1956, p. 170):

$$\chi_r^2 = \frac{12}{Nk\,(k+1)} \sum_{j=1}^{k} (R_j)^2 - 3N\,(k+1)$$

where N = number of rows

k = number of columns

R_j = sum of ranks in j th column

$\sum_{j=1}^{k}$ directs one to sum the squares of the sums of ranks over all k conditions.

Substituting the observed values from Table 3,

$$\chi_r^2 = \frac{12}{(20)\ (4)\ (4+1)} \left[(57.5)^2 + (71.5)^2 + (31.5)^2 + (39.5)^2\right] - (3)\ (20)\ (4+1)$$

$$= 320.13$$

χ_r^2 is distributed approximately as chi square with df = k - 1 when

TABLE 3

RANKS OF TRIALS SCORES OF RETARDED AND BRIGHT SUBJECTS ON SETS C AND A

Subject Pair	Retarded Group Set C	Retarded Group Set A	Bright Group Set C	Bright Group Set A
a	3	4	1	2
b	1	3	2	4
c	3	4	2	1
d	3	4	1.5	1.5
e	3	4	2	1
f	2	4	1	3
g	3	4	1.5	1.5
h	3	4	1	2
i	3	4	1	2
j	3	4	2	1
k	3	4	1.5	1.5
l	3	4	1.5	1.5
m	3	4	1.5	1.5
n	2	1	3	4
o	3	4	1.5	1.5
p	4	3	2	1
q	1.5	3	1.5	4
r	4	3	2	1
s	4	2.5	1	2.5
t	3	4	1	2
R_j*	57.5	71.5	31.5	39.5

* Differences are significant at .001 level.

N and k are as large as they are in the present study. Thus the probability associated with the occurrence under H_o of a value as large as the observed value of χ_r^2 may be determined by reference to a Table of Critical Values of Chi Square (Siegel, 1956, p. 249).

For df = k - 1 = 4 - 1 = 3, $r\chi^2$ as large as 320.13 is significant beyond the .001 level of significance. Therefore, H_o is rejected. The conclusion is that the number of trials required to learn a set of associated items varies either with the type of material learned or with the tested intellect of the learner, or with both. Further tests are required to determine the source (or sources) of variation.

As a further test of the significance of differences between the performances of the two groups on the two sets of learning materials, the Friedman two-way analysis of variance by ranks was used to analyze the errors committed by each subject on each test. The number of errors are ranked in Table 4, and χ_r^2 is computed from the ranked data:

$$\chi_r^2 = \frac{12}{(20)\ (4)\ (4+1)} \left[(56.5)^2 + (72)^2 + (31)^2 + (40.5)^2 \right] - (3)\ (20)\ (4+1)$$

$$= 320.325$$

χ_r^2 for df = k - 1 = 3 at the .05 level of significance is 7.82, and at the .001 level it is 16.27. Therefore, the computed value of 320.325 is significant far beyond the .001 level, and H_0 is untenable. The number of errors committed by bright and retarded subjects varies either with the type of material learned or with the tested intellect of the learner, or with both.

Analyses of trials and errors data are consistent in showing significant differences in the performance of retarded and bright subjects learning two types of materials: paired pictures or semi-concrete materials (SetC), and paired letters and numerals which are more abstract (Set A). The Friedman two-way analysis of variance by ranks, while revealing the presence of significant differences in the four sets of re-

TABLE 4

RANKS OF ERROR SCORES OF RETARDED AND BRIGHT SUBJECTS ON SETS C AND A

Subject Pair	Retarded Group Set C	Set A	Bright Group Set C	Set A
a	3	4	1	2
b	1	3	2	4
c	3	4	2	1
d	3	4	1	2
e	3	4	2	1
f	2	4	1	3
g	3	4	1	2
h	4	2	1	3
i	2.5	4	1	2.5
j	3	4	2	1
k	3	4	1	2
l	3	4	2	1
m	3	4	2	1
n	1	2	3	4
o	3	4	2	1
p	3	4	2	1
q	2	3	1	4
r	4	3	2	1
s	4	3	1	2
t	3	4	1	2
R_j*	56.5	72	31	40.5

*Differences are significant at .001 level.

sults, does not indicate the source of the variation. The following analyses of the data will permit more precise pin-pointing of the factor or factors contributing to the differential performance.

<u>First Hypothesis</u>

The first null hypothesis is that there is no difference in the learning rates of bright and retarded students on semi-concrete material (Set C). This hypothesis is tested by use of (a) trials required to reach the criterion of one perfect performance, and (b) the number of errors committed by subjects in each group in learning the material. The alternate hypothesis is that bright students learn semi-concrete materials with fewer trials and fewer errors than do retarded students.

Since the subjects in the two groups are matched by sex and chronological age, and since only two groups of scores are included in this analysis, a significance test for two related samples is in order. The Wilcoxon matched-pairs signed ranks test is appropriate because the study yields related difference scores which may be ranked in order of absolute magnitude (Siegel, 1956, pp. 75-83).

The statistic employed in the Wilcoxon test is $\underline{T}$ = the sum of the ranks of those differences ($\underline{d}$) which are in the opposite direction from predicted. Since the direction of difference is predicted in the alternate hypothesis, a one-tailed region of rejection is appropriate.

The level of significance chosen is .05. The region of rejection consists ofall values of $\underline{T}$ which are so small that the probability associated with their occurrence under H_o is equal to or less than .05 for a one-tailed test.

Table 5 shows the number of trials required by the twenty pairs of retarded and bright subjects to learn the semi-concrete material to the criterion of one perfect performance. The table shows that only two pairs of subjects, b and n, showed differences in the direction of fewer trials for the retarded subject, and these differences are relatively

TABLE 5

TRIALS OF MATCHED RETARDED AND BRIGHT SUBJECTS ON SET C

Subject Pair	Retarded	Bright	d	Rank of d	Rank with less frequent sign
a	14	2	12	18.5	
b	3	5	-2	-5.5	5.5
c	8	4	4	10	
d	11	3	8	16	
e	8	6	2	5.5	
f	4	3	1	2	
g	13	4	9	17	
h	4	2	2	5.5	
i	7	2	5	12	
j	10	5	5	12	
k	8	5	3	8.5	
l	4	3	1	2	
m	11	6	5	12	
n	5	7	- 2	-5.5	5.5
o	5	4	1	2	
p	15	8	7	15	
q	3	3	0		
r	16	4	12	18.5	
s	9	3	6	14	
t	9	6	3	8.5	
N = 19					T = 11*

* Significant at .005 level.

small: each is ranked 5.5. One pair required an equal number of trials.

The sum of the ranks with the less frequent sign (i.e., in the unexpected direction) equals 5.5 + 5.5 = 11 - T. According to a Table of Critical Values of T in the Wilcoxon Matched-pairs Signed-ranks Test (Siegel, 1956, p. 254), for N = 19 = the number of pairs showing a dif-

TABLE 6

ERRORS OF RETARDED AND BRIGHT SUBJECTS ON SET C

Subject Pair	Retarded	Bright	d	Rank of d	Rank with less frequent sign
a	58	3	55	20	
b	8	19	- 11	- 4	4
c	26	13	13	5.5	
d	54	6	48	19	
e	39	24	15	7	
f	17	11	6	1	
g	46	9	37	17	
h	19	1	18	8	
i	33	6	27	11	
j	47	19	28	12.5	
k	44	16	28	12.5	
l	16	8	8	3	
m	63	34	29	14	
n	8	41	- 33	- 15	15
o	26	13	13	5.5	
p	71	35	36	16	
q	14	7	7	2	
r	40	14	26	10	
s	58	11	47	18	
t	56	31	25	9	
N = 20					T = 19*

* Significant at .005 level.

ference, a T as low as 11 is significant beyond the .005 level of significance. The decision is to reject the null hypothesis and accept the alternate hypothesis. The bright children required statistically significant fewer trials to learn twelve pairs of semi-concrete items than did the retarded children.

Data for testing the first hypothesis by comparing the errors of retarded and bright students on Set C are given in Table 6. The number of errors committed by each subject are given, the difference between the errors scores of each pair of subjects is computed, and the differences are ranked. $\underline{T}$, the statistic employed in the Wilcoxon test, equals the sum of the ranks in the unexpected direction. Table 6 shows that only two differences were in the unexpected direction: these are ranked fourth and fifteenth. The sum of these ranks equals $\underline{T} = 19$. For $N = 20$, the number of subjects showing a difference, a value of $\underline{T}$ as low as 19 is significant at the .005 level for a one-tailed test, which is used because the direction of differences is predicted in H_1. As this is below the chosen significance level of .05, the null hypothesis is rejected and H_1 is accepted. Bright children committed fewer errors on Set C than did retarded children.

Second Hypothesis

The second null hypothesis, that there is no difference in the learning rates of bright and retarded students on abstract materials, was also tested by the previously described Wilcoxon test. The data in Table 7 show that three pairs of ranks were in the unexpected direction. Their summation produced a $\underline{T}$ of 14. One pair showed no difference and was omitted from the analysis. Therefore, $N = 19$. A $\underline{T}$ as low as 14 is significant beyond the .005 level. Using the previously set criterion of significance of .05, the null hypothesis is rejected in favor of H_2. Bright children required significantly fewer trials to learn the abstract materials than did the retarded children.

The second H_o was also tested by the data in Table 8. Four pairs

TABLE 7

TRIALS OF PAIRED RETARDED AND BRIGHT SUBJECTS ON SET A

Subject Pair	Retarded	Bright	d	Rank of d	Rank with less frequent sign
a	16	5	11	16	
b	8	11	-3	-4	4
c	14	3	11	16	
d	18	3	15	19	
e	12	4	8	11	
f	12	5	7	8	
g	14	4	10	13.5	
h	5	3	2	2	
i	10	6	4	5.5	
j	11	3	8	11	
k	17	5	12	18	
l	5	3	2	2	
m	17	6	11	16	
n	3	10	-7	-8	8
o	8	4	4	5.5	
p	14	6	8	11	
q	5	7	-2	-2	2
r	10	3	7	8	
s	4	4	0		
t	17	7	10	13.5	
N = 19					T = 14*

* Significant at .005 level.

of ranks were in the unexpected direction. Their summation produced a Wilcoxon T of 15. For N = 20 pairs of subjects showing the difference, a T as low as 15 is significant beyond the .005 level. As this is below the previously set level of .05, the null hypothesis is rejected and H_2 is accepted. Bright children committed significantly fewer errors in learning the abstract materials to the criterion of one perfect per-

TABLE 8

ERRORS OF PAIRED RETARDED AND BRIGHT SUBJECTS ON SET A

Subject Pair	Retarded	Bright	d	Rank of d	Rank with less frequent sign
a	62	24	38	10	
b	42	46	-4	-2	2
c	63	10	53	13.5	
d	127	8	119	20	
e	63	10	53	13.5	
f	77	20	57	15	
g	53	11	42	11	
h	15	17	-2	-1	1
i	53	33	20	5	
j	73	13	60	16	
k	140	28	112	19	
l	27	5	22	6	
m	72	27	45	12	
n	15	45	-30	-8	8
o	43	9	34	9	
p	92	27	65	17	
q	15	34	-19	-4	4
r	36	8	28	7	
s	24	14	10	3	
t	124	35	89	18	
N = 20					T = 15*

* Significant at .005 level.

formance than did the retarded children. The second hypothesis that the groups would perform equally well on Set A was rejected by trials data and by errors data.

Third Hypothesis

The third null hypothesis, that there is no difference in the learning

TABLE 9

TRIALS OF RETARDED SUBJECTS ON SETS C AND A

Subject	Set A	Set C	d	Rank of d	Rank with less frequent sign
a	16	14	2	7	
b	8	3	5	12.5	
c	14	8	6	15	
d	18	11	7	17	
e	12	8	4	11	
f	12	4	8	18.5	
g	14	13	1	3	
h	5	4	1	3	
i	10	7	3	9.5	
j	11	10	1	3	
k	17	8	9	20	
l	5	4	1	3	
m	17	11	6	15	
n	3	5	-2	-7	7
o	8	5	3	9.5	
p	14	15	-1	-3	3
q	5	3	2	7	
r	10	16	-6	-15	15
s	4	9	-5	-12.5	12.5
t	17	9	8	18.5	
N = 20					T = 37.5*

* Significant at .005 level.

rates of retarded students on semi-concrete materials and abstract materials, was tested by the Wilcoxon statistic T. The null hypothesis was hypothesis was first tested by the data in Table 9, the trials required by the retarded subjects to learn Sets C and A. The data in Table 9 show that only four of the retarded subjects required more trials to learn Set C than they did to learn Set A. These four differences were in the

TABLE 10

ERRORS OF RETARDED SUBJECTS ON SET C AND SET A

Subject	Set A	Set C	*d*	Rank of *d*	Rank with less frequent sign
a	62	58	4	3	
b	42	8	34	14.5	
c	63	26	37	16	
d	127	54	73	19	
e	63	39	24	12	
f	77	17	60	17	
g	53	46	7	5.5	
h	15	19	-4	-3	3
i	53	33	20	10	
j	73	47	26	13	
k	140	44	96	20	
l	27	16	11	8	
m	72	63	9	7	
n	15	8	7	5.5	
o	43	26	17	9	
p	92	71	21	11	
q	15	14	1	1	
r	36	40	-4	- 3	3
s	24	58	-34	-14.5	14.5
t	124	56	68	18	
N = 20					*T* = 20.5*

* Significant at .005 level.

unexpected direction and the summation of their ranks equals *T* = 37.5, which is significant beyond the .005 level for a one-tailed test. N = 20 as all subjects showed a difference in performance on the two tests. Using the chosen significance level of .05, the null hypothesis is rejected in favor of H_3. Retarded children required significantly fewer trials to learn the semi-concrete materials than they did to learn the abstract materials.

The third null hypothesis was also tested by analysis of the number of errors committed by retarded subjects in learning the two sets of materials to one perfect performance.

The data in Table 10 show that three retarded subjects made more errors on Set C than on Set A. This was not in the expected direction. The summation of the ranks of the differences in the unexpected direction produced a Wilcoxon T ≑ 20.5. For N = 20 pairs of subjects, this difference is significant at the .005 level, and the null hypothesis is rejected. Retarded subjects made significantly more errors in learning the abstract materials than they did in learning the semi-concrete materials. The third null hypothesis that the retarded subjects would perform equally well on the two types of materials was rejected by analysis of trials data and errors data.

Fourth Hypothesis

The fourth null hypothesis, that there is no difference in the learning rates of bright students on semi-concrete materials and abstract materials, was also tested by the Wilcoxon statistic T. Table 11 shows the number of trials of the bright subjects on Set C and Set A. Six of the subjects required the same number of trials to learn each set. These six subjects were eliminated from the analysis, therefore, N = 14, the number of subjects showing a difference. Of the fourteen differences ranked, five of the ranks were in the unexpected direction, requiring more trials for Set C. Summation of the ranks of the differences in the unexpected direction produced a Wilcoxon T = 28.5.

For N = 14, the number of subjects showing a difference, the table

TABLE 11

TRIALS OF BRIGHT SUBJECTS ON SET C AND SET A

Subject	Set A	Set C	d	Rank of d	Rank with less frequent sign
a	5	2	3	10.5	
b	11	5	6	14	
c	3	4	-1	-3	3
d	3	3	0		
e	4	6	-2	-7.5	7.5
f	5	3	2	7.5	
g	4	4	0		
h	3	2	1	3	
i	6	2	4	12.5	
j	3	5	-2	- 7.5	7.5
k	5	5	0		
l	3	3	0		
m	6	6	0		
n	10	7	3	10.5	
o	4	4	0		
p	6	8	-2	-7.5	7.5
q	7	3	4	12.5	
r	3	4	-1	-3	3
s	4	3	1	3	
t	7	6	1	3	
N = 14					T = 28.5*

* Not significant at .05 level. (p. = .4404)

of critical values of T (Siegel, 1956, p. 254) does not give the significance level of a T as large as the observed value of T = 28.5. However, T is distributed approximately as z with mean equal to N(N+1) /4 and standard deviation equal to the square root of N(N+1) (2N+1) /24 (Siegel, 1956, p. 79). Therefore,

$$z = \frac{T - \frac{N(N+1)}{4}}{\sqrt{\frac{N(N+1)\,(2N+1)}{24}}}$$

TABLE 12

ERRORS OF BRIGHT SUBJECTS ON SET C AND SET A

Subject	Set A	Set C	d	Rank of d	Rank with less frequent sign
a	24	3	21	17	
b	46	19	27	19	
c	10	13	-3	-4	4
d	8	6	2	1.5	
e	10	24	-14	-15	15
f	20	11	9	13	
g	11	9	2	1.5	
h	17	1	16	16	
i	33	6	27	19	
j	13	19	-6	- 9.5	9.5
k	28	16	12	14	
l	5	8	-3	-4	4
m	27	34	-7	-11	11
n	45	41	4	7	
o	9	13	-4	-7	7
p	27	35	-8	-12	12
q	34	7	27	19	
r	8	14	-6	- 9.5	9.5
s	14	11	3	4	
t	35	31	4	7	
N = 20					T = 72.0*

*Not significant at .05 level. (p. = .1003)

Substituting, $z = \frac{28.5 - \frac{(14)(15)}{4}}{\sqrt{\frac{(14)(15)(29)}{24}}} = -.15$. The probability

associated with a value of $z = -.15$ in the normal distribution is p = .4404 for a one-tailed test. The null hypothesis is accepted. There was no difference in the number of trials required for the bright students to learn the two types of material to the criterion of one perfect performance.

The fourth null hypothesis was also tested by analysis of the number of errors committed by bright subjects in learning the two sets of materials. Table 12 shows that eight of the twenty ranked differences are in the unexpected direction. This means that eight of the twenty bright subjects made more errors on the semi-concrete materials and the remaining twelve bright subjects made more errors on the abstract materials. Summation of the ranks in the unexpected direction produced a Wilcoxon $\underline{T} = 72.0$.

For N = 20, the number of subjects showing a difference, the table of critical values does not give the significance level of a $\underline{T}$ as large as the observed value. As $\underline{T}$ is distributed approximately as $\underline{z}$ according to the formula given on page 56, $\underline{z}$ was computed by substituting the values from Table 12. The probability associated with the obtained value of $\underline{z} = -1.28$ in the normal distribution is p = .1003 for a one-tailed test. The null hypothesis is accepted. There was no significant difference in the number of errors made by bright subjects in learning the two types of materials.

Analysis of trials data and errors data fail to show any statistically significant difference at the previously set .05 level in the learning rates of bright subjects on Sets C and A.

Fifth Hypothesis

To test the fifth null hypothesis, that there is no difference in the ratios of semi-concrete to abstract learning rates of bright and retarded students, it was necessary to compute two ratios for each subject. The trials ratio was computed by dividing the number of trials a subject needed to learn Set C by the number of trials he needed to learn Set A. The resulting ratio was multiplied by one hundred to eliminate decimals. The errors ratio was computed by dividing the number of errors a subject made in learning Set C by the number of errors he made in learning Set A. This ratio was also multiplied by one hundred.

The rationale for using such ratios was that an individual's relative performance on the two tasks is best expressed by a ratio of his performance on each of the tasks. This is equivalent to saying that if one subject requires ten trials to learn Set C and twenty trials to learn Set A and another subject requires five trials to learn Set C and ten trials to learn Set A, so that each subject earned a ratio of fifty, the relative difficulty of Set C as compared with Set A is the same for both subjects. The ratio thus derived may not provide an actual index of ability to learn the two types of materials, but should prove of value in comparing the performance of the bright and retarded groups in terms of their relative facility with the two sets of materials used in this study.

The Wilcoxon test was used to test this hypothesis because it is possible to tell which ratio is larger, to rank the differences in order of absolute size, and because matched subjects are used. The data in Table 13 show that seven of the retarded subjects obtained a higher trials ratio than did the matched bright subjects. Summation of the ranks of these seven subjects yields a value of $\underline{T} = 76.5$. For N = 20 pairs of subjects showing a difference, a value of T as large as 76.5 is not significant at the .05 level, which was the previously chosen

TABLE 13

RATIOS OF SET C TO SET A BY TRIALS (C_t/A_t)
FOR BRIGHT AND RETARDED SUBJECTS

Subject Pair	Ratio (C_t/A_t) Bright	Retarded	d	Rank of d	Rank with less frequent sign
a	40	88	-48	-14	14
b	45	38	7	2	
c	133	57	76	16.5	
d	100	61	39	12	
e	150	67	83	18	
f	60	33	27	6.5	
g	100	96	4	1	
h	67	80	-13	-3	3
i	33	70	-37	-10.5	10.5
j	167	91	76	16.5	
k	100	47	53	15	
l	100	80	20	5	
m	100	65	35	9	
n	70	167	-97	-19	19
o	100	63	37	10.5	
p	133	93	40	13	
q	43	60	-17	- 4	4
r	133	160	-27	- 6.5	6.5
s	75	225	-150	-20	20
t	86	53	33	8	
N = 20					T = 76.6*

* Not significant at .05 level. (p greater than .10)

level of significance. The obtained T is not significant at the .10 level, thus H_0 is not rejected. There is no demonstrated significant relationship between tested intellect and relative difficulty of semi-concrete and abstract materials as measured by the ratio of the number of trials required to achieve one perfect performance on each type of material.

TABLE 14

RATIOS OF SET C TO SET A BY ERRORS(C_e/A_e)
FOR BRIGHT AND RETARDED SUBJECTS

Subject Pair	Ratio (C_e/A_e) Bright	Retarded	d	Rank of d	Rank with less frequent sign
a	13	94	-81	-13	13
b	41	19	22	2	
c	130	41	89	16	
d	75	43	32	4	
e	240	62	178	20	
f	55	22	33	5	
g	82	87	-5	- 1	1
h	6	127	-121	- 18	18
i	18	62	-44	- 8.5	8.5
j	146	64	82	14	
k	57	31	26	3	
l	160	59	101	17	
m	126	88	38	6.5	
n	91	53	38	6.5	
o	144	60	84	15	
p	130	77	53	10	
q	18	93	- 75	-12	12
r	175	111	64	11	
s	79	242	- 163	-19	19
t	89	45	44	8.5	
N = 20					T = 71.5*

* Not significant at .05 level. (p = .10.)

The fifth hypothesis was also tested by comparing the errors ratios of the two groups. The Wilcoxon T was again used and the .05 level of significance was chosen as the criterion of significance of difference. The data in Table 14 show that six of the retarded subjects obtained a higher errors ratio than did the matched bright subjects. Summation of the ranks of these six subjects yields a value of T = 71.5. For N = 20 pairs of subjects showing a difference, a value of T as large as 71.5 is not significant at the .05 level. The probability associated with a T as large as the obtained value is approximately p = .10. Thus, the fifth null hypothesis is not rejected. There is no demonstrated significant relationship between tested intellect and relative difficulty of semi-concrete and abstract materials as measured by the ratio of the number of errors committed in learning each type of material to the criterion of one perfect performance.

While the fifth null hypothesis was not rejected, it is retained with some caution because there was a consistent but not statistically significant difference in the direction of greater facility with abstract materials by the bright subjects as indicated by their higher trials ratio and errors ratio.

Sixth Hypothesis

The sixth null hypothesis isthat there is no difference in the frequency of expressed greater difficulty with abstract materials by bright and retarded students. The alternate hypothesis H_6 is that the retarded students will more frequently express greater difficulty with abstract materials.

The responses to two questions provide the data for testing this hypothesis. The data in Table 15 show the frequency with which subjects in bright and retarded groups expressed feelings of greater difficluty with the abstract materials in response to the two questionnaire items:

1. Which set seemed more difficult while you were taking it?

2. On which set do you feel you made a better score?

The data in the two rows of Table 15 were independently analyzed by the binomial test. In each test, the sample includes those subjects expressing feelings of greater difficulty with Set A by response to the question represented by a row of the data. The .05 level of significance was chosen.

TABLE 15

FREQUENCY OF EXPRESSED GREATER
DIFFICULTY WITH SET A

	Retarded	Bright	Total
1. Seemed more difficult while taking it:	15	13	28
2. Estimated better score on Set C:	15	14	29

The binomial test is of the goodness-of-fit type in that it indicates whether it is reasonable to believe that the proportions (or frequencies) observed in a sample could have been drawn from a population having a specified value of proportions. Under the null hypothesis we would expect that an equal number of bright and retarded subjects would express feelings of greater difficulty with Set A. If P = proportion of cases expected in one of the categories, and Q = I - P = proportion of cases expected in the other category, then the null hypothesis may be expressed as H_0: $P = Q = \frac{1}{2}$ of N in each category. Because the alternate hypothesis predicts the direction of difference, a one-tailed test is appropriate.

When N is 25 or greater, the binomial distribution tends toward the normal distribution, and H_o may be tested by

$$z = \frac{(x \pm .5) - NP}{\sqrt{NPQ}}$$

where x = the smaller frequency

N = the total number of subjects indicating greater difficulty with Set A by response to this question P = Q = $\frac{1}{2}$ = the proportion of frequencies in each category expected under H_o.

x+.5 is used when x is less than NP

x-.5 is used when x is greater than NP.

Substituting the observed frequencies for Question #1 in Table 15, $z = \frac{(13 + .5) - (28)(.5)}{\sqrt{(28)(.5)(.5)}} = -.19.$

By reference to a Table of Probabilities Associated with Values as Extreme as Observed Values of z in the Normal Distribution (Siegel, 1956, p. 247), the one-tailed probability associated with the observed value of $z = -.19$, is p = .4247. As this is much greater than the previously chosen .05 level of significance, the sixth null hypothesis is retained.

The data for Question #2 yields a value of $z = 0$, which has an associated probability of p = .50. Again, the null hypothesis is retained. There is no difference in the frequency of expressed greater difficulty with abstract materials by bright and retarded students.

Seventh Hypothesis

The seventh null hypothesis, that there is no difference in the frequency of expressed preference for learning concrete material by bright and retarded students, was also tested by the binomial test.

This test is appropriate because the data (Table 16) are in two discrete categories (bright and retarded) and those subjects expressing a preference for Set C constitute the sample being studied.

TABLE 16

FREQUENCY OF STATED PREFERENCE FOR LEARNING SEMI-CONCRETE MATERIAL

Retarded	Bright	Total
10	12	22

The level of significance chosen is .05. N = 22, the total number of subjects expressing a preference for Set C in response to the third question:

> If you had to spend a long time in studying one type of material, which type would you rather learn?

As the alternate hypothesis predicts the direction of expected difference, a one-tailed test is used.

Siegel (1956, p. 250) gives the probability associated with the occurrence under H_o of an observed value as small as $x = 10$, the smaller of the two frequencies in Table 16, when N = 22. The probability associated with the observed value is $p = .416$, which is greater than the criterion of .05. The seventh null hypothesis is retained. Bright and retarded students did not significantly differ in the frequency with which they expressed a preference for semi-concrete material rather than abstract material.

Summary of Results

In summary, the following statistically significant differences were found:

Bright students required fewer trials and made fewer errors in learning semi-concrete material than did retarded students.

Bright students required fewer trials and made fewer errors in learning abstract material than did retarded students.

Retarded students required fewer trials and made fewer errors in learning semi-concrete material than they did in learning abstract material.

The following differences were not statistically significant:

There was no statistically significant difference in the number of trials required or in the number of errors committed by bright students in learning the two sets of material. The bright students made fewer errors on the semi-concrete material than on the abstract material, but the difference was not significant beyond the .10 level.

There was no statistically significant difference in the relative difficulty of the two types of material for bright and retarded students, as expressed by ratios of trials on Set C divided by trials on Set A and errors on Set C divided by errors on Set A. The bright students obtained higher C/A ratios for trials and errors, but the difference was not significant beyond the .10 level.

There was no statistically significant difference in the subjective expression of greater difficulty in learning the abstract material by bright and retarded students.

There was no statistically significant difference in the frequency with which bright and retarded students expressed a preference for learning the semi-concrete material.

CHAPTER V

SUMMARY AND CONCLUSIONS

An assumption that is frequently implied and sometimes stated as fact is that mentally retarded children learn concrete material relative easier than they do abstract, symbolic material, such as are involved in academic subjects. Conversely, bright children reputedly are more advanced in their ability to learn abstract material than in their concrete learning ability. Such assumptions are based in part upon observational data which indicate that retarded students do not perform as well in highly academic subjects as they do in less academic areas (Ingram, 1953; Hutt and Gibley, 1958; Cutts and Moseley, 1957; Adams and Torgerson, 1956; Scheifele, 1953; Sorenson, 1954; Terman and Oden, 1947). The notion of differential performance on concrete and abstract material as an identifying characteristic of retardation or brightness receives some support from psychologists (Freeman, 1955) who consider ability to deal with symbols as a higher level of mental activity than concrete learning, and from analysis of differential performance on intelligence test items by bright and retarded subjects (Baldwin, 1948; Magaret and Thompson, 1950).

Empirical studies that have attempted to determine the relationship between tested intelligence and learning rates for various types of materials tend to differ in respect to the response required of the subject and the number of associations required as well as in respect to the abstractness of the material learned (Hollingworth and Cobb, 1928; Garrett, 1928; Wilson, 1928; Ellis, 1960). Analysis of the steps involved in the process of learning (Wilson, 1931; Dennis, 1942) support the hypothesis that bright and retarded children learn by the same processes. This view is consistent with traditional learning theory (Deese, 1952; Hull, 1943; Skinner, 1938; Mowrer, 1960), which attempts to achieve unity of theory applicable not only to dofferent intellectual levels but also across species lines. Some of the more concrete tasks that have failed to distinguish bright from retarded subjects have perhaps been too simple to reveal any differences (Ellis, 1960; Eisman, 1958).

In the present study, twenty bright and twenty retarded adolescent students learned two sets of paired items by the associative learning method. Each set contained twelve pairs of items. The abstract material (Set A) consisted of twelve pairs of matched numerals and letters, and the semi-concrete material (Set C) consisted of twelve pairs of matched outline pictures of real objects. For each task, one trial consisted of a presentation of the twelve pairs of items in a set followed by a presentation of twelve cards showing only the first item of the pair. The response required was for the subject to name the missing item that was originally paired with the item shown on the test card. Thus the tasks were equivalent in number of associations required for a trial and in response required. The tasks differed only in the relative abstractness of the stimulus items. The number of trials necessary to reach the criterion of one perfect performance and the number of errors made in reaching the criterion were recorded for each subject. Relative rates for learning the two sets were determined by computing ratios of Set C/Set A for trials and for errors. Three questions were asked at the termination of testing to determine the subjects feelings about the relative difficulty of the two sets and preference for learning each type of material.

The results showed that bright subjects required fewer trials and made fewer errors than retarded subjects on both semi-concrete and abstract material. The retarded subjects required fewer trials and made fewer errors in learning the semi-concrete material than they did in learning the abstract material. There was no statistically significant difference in trials or errors of the bright students on the two sets of material, but the direction of the difference tended toward better performance on the semi-concrete material. The Set C/Set A trials ratios and errors ratios were not significantly different for the bright and retarded students. The direction was in favor of relatively higher ratios for the bright students at the .10 level. There was no difference in the expression of greater difficulty with abstract material or with preference for semi-concrete material by bright and retarded students.

One conclusion drawn from this study is that, irregardless of the type of material being learned, learning rate is directly related to tested intellect, provided that the task is sufficiently difficult to reveal the difference. This is consistent with previous findings (McGeoch, 1942). Eisman (1958) concluded that her failure to find differences in learning rates for pictorial material may be due to the simplicity of the task.

Another conclusion is that there is no absolute relationship between intellect and performance on either type of task. There was variability within each group. Some of the retarded subjects performed better on both abstract and semi-concrete materials than did the matched bright subjects. Also, some of the retarded subjects performed better on abstract material than they did on semi-concrete material, and many of the bright subjects resembled the retarded subjects in showing relatively better performance on the semi-concrete material than on the abstract material, as evidenced by trials ratios and errors ratios.

A further conclusion is that bright and retarded students do not differ in their subjective estimates of the difficulty of material on the basis of the relative abstractness of the items being learned, nor do they differ in their preference for learning materials differing in degree of abstractness.

Another conclusion that is not derived directly from analysis of the data, but is based on interviews with each subject by a classroom teacher several days after the testing was completed, is that the two groups do not differ in their willingness to participate in further testing situations of this type. The experimenter requested that a teacher tell the subjects in a classroom situation that further tests were being considered, and asked for volunteers from the class. Only two of the subjects used in this study, one bright and one retarded, failed to volunteer as subjects for further testing. The conclusion drawn is that the retarded subjects did not feel more threatened in their role as subjects in this experiment than did the bright subjects.

It is also concluded that the assumption that retarded children have a greater facility with semi-concrete material than with abstract material is justified. The converse assumption is not justified. Bright children do not have greater facility with abstract material than with semi-concrete material.

Inspection of the data for retarded subjects leads to the conclusion that the retarded subjects do not constitute a homogeneous group in regard to their learning abilities. They were much more variable in performance than the bright group. This is consistent with previous findings (Eisman, 1952; Reynolds and Stacey, 1955). Further research might prove fruitful with a repeat of the study using retarded subjects matched by I.Q. but differing in etiological classification. None of the subjects in the present study had any known organic damage recorded on their school medical records, but it is doubtful whether a complete neurological examination had been performed on most of the subjects.

In conclusion, results of this study support the present trend toward concretization of learning experiences for retarded students. The results do not support educational programs for bright students that tend toward maximumization of abstraction. While the results for the bright subjects were not statistically significant, the direction of difference tends toward better performance on the semi-concrete material.

It appears probable that the data obtained from analysis of intelligence test performance showing bright individuals to be relatively better on abstract than on semi-concrete items indicates not that bright subjects are better on abstract than on concrete items, as is often assumed, but rather that relatively more of the retarded subjects in the test's standardization sample performed poorly on the items having abstract content. There is a difference in saying that bright subjects perform better on abstract than on concrete tasks, as is frequently done in the literature, and in stating the more probable hypothesis that most people perform better on concrete tasks, but that the tendency is more marked in the case of retarded individuals.

It must also be remembered when generalizing from intelligence test performance that the more abstract tasks also usually require more associations and are more difficult in terms of the response required of the subject.

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APPENDIX

APPENDIX

TABLE 17

SEX, INTELLIGENCE QUOTIENT, AND AGE OF SUBJECTS IN RETARDED AND BRIGHT GROUPS

Subject Pair	Retarded Group I.Q.	Retarded Group C.A.*	Sex	Bright Group I.Q.	Bright Group C.A.*
			Males		
a	70	12-3		128	12-4
b	79	12-4		125	12-7
c	75	13-3		119	13-2
d	73	13-3		143	13-4
e	70	13-5		129	13-5
f	80	13-9		136	13-7
g	63	13-10		127	13-9
h	76	14-1		122	13-11
i	64	14-6		138	14-4
j	76	15-0		131	14-11
			Females		
k	76	12-6		120	12-5
l	62	12-11		120	12-11
m	76	13-5		124	13-6
n	53	13-5		124	13-6
o	65	13-9		137	13-8
p	67	14-3		134	14-2
q	64	14-4		122	14-7
r	64	14-6		122	14-8
s	56	14-7		127	14-9
t	66	15-1		127	15-4

*Chronological age is given in years-months.