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ABSTRACT

The purpose of this study was to determine the relationship of method of presentation, grade level, sex, and achievement within grade and sex to the various bases upon which children of low socioeconomic background classify geometric concepts. Two tasks were administered to 96 subjects in the fifth, eighth, and eleventh grades--32 at each grade level. Task I was an equivalence task comprised of a sequential presentation of eight geometric concept cards. Half the subjects were given a verbal presentation while the other half were given a pictorial presentation. Subjects were asked to explain likenesses and differences between stimuli. Task II was a free sorting exercise. Subjects were presented with a 26-item picture array, asked to select from the array cards which were alike, and to explain the bases of their groupings. Task I responses were classified into Perceptible, Nominal, and Subject-Fiat categories; for Task II responses, only Perceptible, Attribute, and Nominal categories were used. This study found, contrary to expectation, that low SES children in grades 5, 8, and 11 do not vary significantly from one another in their bases of classifying geometric figures. Achievement, method of presentation, and sex were also found not to be a significant influence on bases of classification. (Author/AG)

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A STUDY OF CLASSIFICATORY BEHAVIOR IN LOW SOCIOECONOMIC STATUS CHILDREN OF VARYING CHARACTERISTICS

Report from the Project on Variables and Processes in Cognitive Learning

By Gordon Kenneth Nelson

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The Wisconsin Research and Development Center for Cognitive Learning focuses on contributing to a better understanding of cognitive learning by children and youth and to the improvement of related educational practices. The strategy for research and development is comprehensive. It includes basic research to generate new knowledge about the conditions and processes of learning and about the processes of instruction, and the subsequent development of research-based instructional materials, many of which are designed for use by teachers and others for use by students. These materials are tested and refined in school settings. Throughout these operations behavioral scientists, curriculum experts, academic scholars, and school people interact, insuring that the results of Center activities are based soundly on knowledge of subject matter and cognitive learning and that they are applied to the improvement of educational practice.

This Technical Report is from the Project on Variables and Processes in Cognitive Learning in Program 1, Conditions and Processes of Learning. General objectives of the Program are to generate knowledge and develop general taxonomies, models, or theories of cognitive learning, and to utilize the knowledge in the development of curriculum materials and procedures. Contributing to these Program objectives, this project has these objectives: to ascertain the important variables in cognitive learning and to apply relevant knowledge to the development of instructional materials and to the programming of instruction for individual students; to clarify the basic processes and abilities involved in concept learning; and to develop a system of individually guided motivation for use in the elementary school.

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ABSTRACT

The purpose of this study was to determine the relationship of method of presentation, grade level, sex, and achievement within grade and sex to the various bases upon which children of low socioeconomic background classify geometric concepts. This study was designed as a replication of a recent experiment (Wiviott, 1970) carried out with high socioeconomic status children. Two tasks were administered to 96 subjects in the fifth, eighth, and eleventh grades--32 at each grade level. Task I was an equivalence task comprised of a sequential presentation of eight geometric concept cards. Half the Ss were given a verbal presentation while the other half were given a pictorial presentation. Ss were asked to explain likenesses and differences between stimuli. Task II was a free sorting exercise. Ss were presented with a 26-item picture array, asked to select from the array cards which were alike, and to explain the bases of their groupings. Task I responses were classified into Perceptible, Attribute, Nominal, and Subject-Fiat categories; for Task II responses, only Perceptible, Attribute, and Nominal categories were used.

This study found, contrary to expectation, that low SES children in grades 5, 8, and 11 do not vary significantly from one another in their bases of classifying geometric figures. Achievement, method of presentation, and sex were also found not to be a significant influence on bases of classification. Low SES Ss gave more Perceptible responses and fewer Nominal responses than high SES Ss in Wiviott's study.

Chapter I

INTRODUCTION

In recent years, there has been a burgeoning collection of research evidence indicating that children and adults learn about their environment by rendering things equivalent. For man to understand the world around him, and subsequently to be able to cope effectively with all the complexities and multiformities of life, he must learn to group objects on the basis of relevant properties.

This sorting process, referred to as "classificatory behavior" or "equivalence formation," cannot be undervalued. Differentiating among objects according to their properties and generalizing to new instances is a preliminary step toward the development of conceptual thinking behavior.

With children, the ability to form equivalence has attracted considerable attention. Studies have demonstrated rather persuasively that this is a learned achievement manifested in varying degrees depending upon the level of cognitive growth (Bruner, Olver, Greenfield, et al., 1966). Not all children exhibit the same level of classificatory behavior; some school children, in fact, show deficiency in versatile classification of objects and rely upon an early acquired way to do their grouping.

The present study was designed as a replication of features of previous investigations, particularly the study of Wiviott (1970), on the development of classificatory behavior among school children. In her study, Wiviott extended the conclusions of Jerome Bruner and his co-workers (Bruner, et al., 1966) to the classroom setting. To continue in the same spirit, it was hoped that this study could inspire new directions for instructional practices.

Operationally, classification is simply the process whereby one groups at least two objects together because they are alike in some way. Piagetian theory holds that "classification implies a relation of resemblance between members of the same class, and one of dissimilarity between members of different classes" [Inhelder & Piaget, 1964, p. 5]. Proficiency at making equivalence judgments on a higher operational plane ensues only through cognitive growth and experience.

Equivalence formation is also an important construct in the cognitive theory of Bruner (1964). His three "modes of representation"--enactive, ikonic, and symbolic--are means of representing the information which human beings encounter in their complex environment. In the enactive stage of representation, the young child attempts to unravel the mysteries of the world through his repertory of motor activity; after a time he relies increasingly upon the organization of selected images from his perceptual field (ikonic); and still later, the child slowly starts translating his actions and images into language (symbolic). This last stage ranks highest in the internal representation of experience. Together these modes enable the child to better understand, to "know," and to interact with his surroundings.

Representational growth "is reflected in the changing ways that children have for imposing equivalence on things of their world" [Bruner, et al., 1966, p. 68]. Bruner theorized that enactive, ikonic, and symbolic representation, for instance, might each accentuate different features of the environment, resulting in different bases of classification. For enactive representation, equivalence might be formed on the basis of some action frequently performed on certain objects, while with ikonic representation things might be brought together for their perceptual affinity. And grouping under symbolic representation might be regulated by the conventional categories and the structure of one's language.

The purpose of this study was to determine the relationship of method of presentation, grade level, sex, and achievement level within grade and sex to the various bases by which children of low socioeconomic background classify geometric concepts. In addition, results of the experiment can be compared with the findings of Wiviott (1970), whose sample consisted of high socioeconomic status (SES) subjects.

Hypotheses: This study tested the following propositions:

(i) Low SES children in grades 5, 8, and 11 differ in their bases of classifying geometric figures. Children in the lower grade levels categorize more on perceptible bases than children in the upper grades. Conversely, children in the upper grade levels categorize more upon attribute and nominal bases than children in the lower grades.

(ii) Low SES children of high and low achievement differ in their bases of classifying geometric figures. Low achievers give more perceptible responses than high achievers, while high achievers give a greater predominance of attribute and nominal responses than low achievers.

(iii) Low SES boys and girls do not differ in their bases of classifying geometric figures.

(iv) Verbal and pictorial methods of presentation have a significant effect on the bases of classifying geometric figures among low SES children. A pictorial presentation elicits more perceptible responses than a verbal presentation.

(v) The total number of correct classifications differs only as a function of achievement level. High achievers give more correct responses than low achievers.

A total of 96 students from a low SES urban population served as subjects for this experiment. Three grade levels were used: fifth, eighth, and eleventh grades. At each grade level, the population of low

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SES children was stratified according to sex and mathematics achievement level within grade and sex. Subjects were randomly selected from the stratified population and then randomly assigned to either a verbal or pictorial treatment group for the first task.

Two tasks were administered consecutively to each subject under individual testing conditions. The first was an equivalence task consisting of eight geometric concept cards presented in a fixed order. The array was comprised of the concepts <u>square</u>, <u>rectangle</u>, <u>rhombus</u>, <u>parallelogram</u>, <u>quadrilateral</u>, <u>triangle</u>, <u>circle</u>, and <u>cube</u>. Half of the subjects (<u>S</u>s) received cards having the concept name printed on them (verbal group); the other half received cards with the appropriate geometric figures drawn on them (pictorial group). Each <u>S</u> was presented with the first two cards and asked to explain how they were alike. Next, the third concept card was presented and the <u>S</u> was asked how it differed from the first two and how all three were alike. This procedure continued until all cards had been presented with <u>cube</u>, the last card, representing the contrast item.

The second task was a free-sort entailing 26 geometric concept examples printed on individual cards. The concepts were the same as in the first task (except <u>cube</u> was eliminated), but examples varied along the irrelevant dimensions of size and orientation. The <u>S</u> was asked to construct groups of pictures by selecting those figures that appeared alike to him in some way and to tell the basis for his grouping. After completing a group, the <u>S</u> was asked to repeat the operation until seven groups had been formed, and each time the rationale for the classification was requested.

Responses from each S on Task I were categorized according to four bases of classification: Perceptible, Attribute, Nominal, and Subject-Fiat. The responses given on Task II were categorized according to only three bases of classification: Perceptible, Attribute, and Nominal. The Perceptible basis of classification refers to items rendered equivalent by specifying immediate phenomenal qualities, such as color or size. The Attribute basis refers to items rendered equivalent by specifying a particular attribute of the concept. Nominal basis refers to items rendered equivalent by giving a name or label (supraordinate concept) appropriate to the items. And, Subject-Fiat refers to items rendered equivalent without providing any further information as to the basis of this grouping.

Chapter II

REVIEW OF RELATED RESEARCH

The Nature of Classificatory Behavior

The study of classificatory behavior has been pursued intermittently for the past fifty years, although only in the last ten years have we seen persistent attention given to this phenomenon of cognitive development. Descoudres (1914), a French psychologist, conducted one of the first developmental studies to ascertain how concepts of color, form, and number evolve with age. Her early experiments were concerned with the way abnormal children classify things; these experiments later served as the impetus toward observing how classificatory behavior unfurls in normal children. Using five tasks which required subjects to choose between form and color, number and color, and number and form, given geometric and familiar household items, Descoudres found that children 3-6 years of age preferred color over both form and number as a basis for grouping objects together. While this was the case in early childhood, children in the 7-8 age group were noted to desire form over both color and number, a preference which continued through adulthood.

Brian and Goodenough (1929) obtained results similar to those of Descoudres when the same age-group comparisons were made. In addition, they discovered that children below three years of age show a striking preference for grouping on the basis of form rather than color. Despite a transient preference for classifying with color from about ages 3-6, form preference once again reappears by age six and remains as the most salient basis of classification.

While there have been many investigations dealing with color and form preference in young children--including Kagan and Lemkin (1961) and Harris, Schaller, and Mitler (1970) among others--most of these confirm the general finding that young children prefer color matchings and older children prefer form matchings. Where these studies differ is usually with respect to the exact transition period. Suchman and Trabasso (1966) suggest that the "critical transition age" varies for individuals and that studies of the present kind are unlikely to discern a distinct transition age.

Reichard, Schneider, and Rapaport (1944) utilizing Weigl Color-Form and Sorting tests discovered a steady increase with age in the ability to match objects which belong together. Their study led to a tentative set of norms for the development of conceptual abilities. Three levels of conceptual development were identified: concretistic, functional, and conceptual. The first level (concretistic), typically found in children 5-6 years of age, is characterized by classifications made on the basis of noncritical extraneous features of the objects. In the second level of concept formation (functional), most prevalent in children 8-9 years of age, classifications are based upon the use or function of objects. Finally, in the last level of development (conceptual) classifications are constructed on the basis of abstract properties or relations between objects.

Valuable investigations of classificatory phenomena have also been carried out by the famous Swiss genetic epistemologist, Jean Piaget. Because of his contributions as a penetrating observer and prolific writer of child development, he is generally acclaimed as the most outstanding theorist in the field of cognitive development.

Classificatory behavior, according to Piaget (1954), commences during the first two years of childhood. Beginning with the use of reflexes and his first acquired associations, the child succeeds in constructing a system of schemes for making unlimited combinations of things. This behavior manifests itself as a part of the child's "sensorimotor intelligence" (0-2 years) and presages the development of logical concepts and relations. In the last phase of their development, these schemes can permit certain spontaneous and internal regroupings which are equivalent to mental deductions and construction. Eventually, a coherent universe emerges from the chaos of initial egocentric perceptions when objects, causality, space, and time become elaborated.

The formative years of the child's classificatory development occur during the preoperational period (2-7 years). At this time, the child first becomes capable of classifying two objects together on the basis of one attribute, and later he is able to group more objects together with multiple attributes.

Subsequently, the child can move from groupings based on observable characteristics to groupings made according to unseen or inferred attributes. The ability to make valid inferences about class membership and class inclusion requires the further development of cognitive tools that come only when the child approaches the stage of concrete operations. At this point, the child's thinking includes objects and classes of objects that are not placed before him.

Inhelder and Piaget (1959) described eleven partially ordered steps in the development of classificatory behavior. The process begins when the child groups two objects together because they appear alike to him in some way (resemblance sorting). Soon the child enlarges the scope of his classificatory activity by grouping more than two objects (consistent sorting), while some time later he becomes capable of grouping all objects that can be considered alike in some respect (exhaustive sorting).

The child also learns what bases for classification are acceptable. Physical proximity is preferred less as a means of grouping since the resultant groupings are temporal (conservation). The ability to form successive and simultaneous classifications and to understand class inclusion is acquired with experience in constructing one class at a time. The child eventually will recognize that objects can be assigned to more than one category (multiple class membership); he practices with various attributes as the basis for grouping (horizontal classification). The method for selecting criteria becomes more complex as the child's logical abilities develop. Successive classes are constructed by single attributes and then by combinations of attributes (hierarchica classification). By the use of these combinations the child finally learns to form classes that stand in an inclusion relationship to each other. Class inclusion is therefore the product of these experiences of dealing with diverse attributes and diverse schemes of attribute combination.

When children achieve the understanding that objects fit into more than single class and that classes tend to overlap, they start using terms like "some" and "all." In addition, with the acquisition of important verbal tools for comparison, they can join subclasses to form superordinate classes (A + A' = B), divide superordinate classes into component parts (B - A' = A), and make transformations (B > A). This is understood to be the course of classificatory growth in Piagetia terms.

Kofsky (1966) utilized the technique of scalogram analysis to test Piaget's eleven sequentially ordered steps in the attainment of classificatory concepts. According to Piagetian theory, children acquire the concept of "class inclusion" by building upon rudimentary equivalence formations via these eleven steps. Kofsky translated these steps of classificatory development into eleven experimental tasks designed to determine whether the level of difficulty coincided with the developmental sequence outlined by Piaget and to ascertain whether Ss who had mastered a particular rule had also mastered all the simpler prerequisite rules.

In her experiment, 122 preschool and elementary school children between the ages 4-9 were required to demonstrate their understanding of each of the eleven classificatory operations. This entailed the correct manipulation of a set of geometric blocks administered in a random order to each subject. Results revealed that the order of difficulty of the eleven tasks coincided with Piaget's predicted order, but no set order of mastery prevailed such that facility with the more difficult items implied the same success with easier items.

Allen (1970) replicated Kofsky's study again using scalogram analysis. The general findings in this experiment indicated that the eleven items do not constitute an ordered sequence as hypothesized by Piaget, where passage of one task necessarily implies passage on all lower rank items. Allen concluded that an order of task emergence does exist for these eleven items, although there tends to be considerable overlapping for many of the stages. Nevertheless, the general order of emergence is clear: children acquire grouping skills first and class inclusion skills last.

Lowery and Allen (1969) explored the lowest level of Piaget's classification hierarchy, resemblance sorting, with the use of visual stimulus material. Their procedure consisted of presenting 120 first grade children the Visual Resemblance Sorting Test (VRST), a test of 35 geometric and non-geometric drawings to be classified along three dimensions: size, shape, pattern or a combination of these dimensions.

Ss were required to match or differentiate the figures on the basis of one, two, or three of the attributes, and their responses were scored as either correct or incorrect. The investigators found that shape was easier for children to use as a basis of sorting than pattern, and pattern was easier than size. In addition, a single attribute was easier to deal with than a combination of attributes. Geometric figures were sorted with greater ease than non-geometric figures.

Another study using Piagetian tasks was carried out by Wei (1967) who compared the classificatory behavior of socially disadvantaged children with that of middle class children in kindergarten and second grade. Tasks related to "changing criteria," "object classification," "class-inclusion," and "matrices" were administered to 20 disadvantaged and 20 middle class children at each grade level. The results supported Piaget's theory of a sequential stage development for these classification tasks. While the ability to classify improved with age in both groups, the disadvantaged group of children advanced more slowly in classificatory development than children in the middle-class group.

Raven (1970) developed instructional materials to teach the classification skills postulated by Piaget. The exercises utilized a deductive-generalization method to present the skills to second and third graders. These exercises were contained in booklets which were comprised of geometric frames, transfer frames, and test frames. Ss were divided into three groups: treatment group 1 received classification books 1-12 covering rules for simple grouping classes and rules for hierarchical classification; treatment group 2 performed on booklets 6-12 which entailed only rules for hierarchical classification; and group 3, the control group, was given colored pictures to draw. Treatment group training occupied 15 minutes of a student's time each day for 24 days of instruction. Results showed that the experimental treatment groups performed significantly better on the posttest than the control group. However, no differences existed between the two treatment groups on the classification test total score.

Aside from these investigations of classificatory behavior related to Piagetian theory, the research of Bruner and his co-workers, Olver and Rigney, merit special attention. Their findings (Bruner, Goodnow, & Austin, 1956; Bruner & Olver, 1963; Bruner, Olver, & Greenfield, 1966; Olver, 1961; Olver & Rigney, 1966; Rigney, 1962) will be reviewed in greater detail because of the meaningful role they play in the present study.

Olver (1961) traced the development of equivalence formation in children ages 6-19 using verbal materials. She devised two word arrays for which her 60 Ss were to tell how the items were alike and different. The two arrays consisted of the following words:

1. Banana, peach, potato, meat, milk, water, air, germs (ingestible items) and stone.

2. Bell, horn, telephone, radio, newspaper, book, painting, education (message items) and confusion.

Each child was presented the words banana and peach typed on small cards, one word per card. The S was then asked "How are banana and peach alike?" Potato was then similarly presented for the child and he was asked, "How is potato different from banana and peach?" And then, "How are banana, peach, and potato all alike?" This procedure was followed until all items of the two arrays were administered. The last items in each group were included only for contrast with the other words. For instance, "How is stone different from banana, peach, potato, meat, milk, water, air, germs?" The task items become more diverse and increasingly more difficult as words are added. Table 1 lists the various bases on which the items were judged to be alike.

The results indicated that younger children (six years of age) grouped items more frequently according to perceptible properties than did the older children. There was a steady incline with age toward the use of the intrinsic functional basis of classification and less use of the perceptible bases of grouping. Hence Olver's study supports the theory that equivalence making develops with age. Young children are immediately preoccupied with making associations on the basis of perception while later, through growth, they begin to link things more by functional properties.

In another experiment, Rigney (1962) studied classificatory behavior using an array of 42 common pictures. Besides the use of pictorial rather than verbal material, her experiment differed from Olver's test in that the Ss (90 suburban school boys 6-11 years of age) were

Table 1

Bases of Classification Used in the Olver Study

1. Perceptible: The child may render the items equivalent on the basis of immediate phenomenal qualities such as color, size, shape, or on the basis of position in time or space.

   Perceptible Intrinsic — They are ________. (X:adjective: ". . . both yellow.") They have ________. (X:noun: ". . . writing on them.")

   Perceptible Extrinsic — They are (preposition) ________. (X:position in time or space: ". . . all in a house.")

2. Functional: The child may base equivalence on the use or function of the items, considering either what they do or what can be done to them.

   Functional Intrinsic — They ________. (X:verb: ". . . make noise.")

   Functional Extrinsic — You ________ them. (X:verb: ". . . can turn them on.")

3. Affective: The child may render the items equivalent on the basis of the emotion they arouse or of his evaluation of them.

   Affective — You ________ them. (X:value or internal state: ". . . like them both.") They are ________. (X:adjective indicating value: ". . . very important.")

4. Nominal: The child may group the items by giving a name that exists ready-made in the language.

   Nominal — They are (or are not) ________. (X:noun: ". . . both fruit.")

5. Fiat Equivalence: The child may merely state that the items are alike or are the same without giving any further information as to the basis of his grouping, even when he is prodded.

   Fiat Equivalence — "A" is (or is not) ________ "B." (X:like, similar to, the same as, and so forth: "They are the same thing, really.")

Source: Bruner, Olver, Greenfield, et al., 1966, pp. 71-72.

asked to select for themselves pictures that were "alike in some way" and to form a group. The drawings were illustrations of common objects such as scissors, a doll, a garage, clothing, etc. Ss were allowed to form their groups in any way at all and asked to state how the pictures that they chose were similar. The pictures were replaced into their original positions and new groups were then constructed, repeating this task ten times.

Rigney hypothesized that because of the use of pictures a greater inclination toward perceptible attributes would be observed while few classifications based on functional characteristics would occur. True enough, the Ss responded with considerably more perceptible responses than Olver's subjects; however, the use of perceptible properties as a basis for classifying declined with age--a trend which paralleled that found by Olver. Six-year-olds gave the greatest number of perceptible responses, while the older age groups used functional attributes and nominally based equivalence more often than younger children.

Regardless of whether the stimuli consisted of pictorial or verbal material, the studies of Olver and Rigney reaffirm the position that equivalence formation is a developmental process. Classificatory behavior for younger children largely reflects the imagery in their representation of experience. Children ostensibly depend less upon this single mode of response when the ability to make symbolic representations achieves maturation; higher-order bases of equivalence such as the functional intrinsic then predominate.

And finally, Wiviott (1970), who picked up the research of Olver and Rigney, furnishes us with some additional information on the nature of equivalence making. In her study the effects of subject characteristics and the kind of materials used by Olver and Rigney were of crucial concern. Specifically she wanted to determine the relationship of method of presentation, grade level, achievement level, and sex to the various bases on which students classify geometric concepts. Five questions were posed in the experiment:

1. Do children in grades 5, 8, and 11 differ in their bases of classifying geometric figures?

2. Do children of high and low mathematical achievement differ in their bases of classifying geometric figures?

3. Do boys and girls differ in their bases of classifying geometric figures?

4. What are the effects of a verbal presentation and a pictorial presentation on the bases of classifying geometric figures?

5. Does the degree of correctness of the responses differ between grade levels, achievement levels, sexes and methods of presentation?

Utilizing geometric concepts for the sake of explicitness and their indigenous role in the classroom, Wiviott reasoned that this approach might yield vital information on how children group pertinent classroom concepts.

Two tasks were devised for this experiment. The first consisted of a sequential presentation of eight geometric concept cards resembling

Olver's word arrays. The array included square, rectangle, rhombus, parallelogram, quadrilateral, triangle, circle and cube. Ss were divided into two treatment groups, one group which was presented cards with a picture of a concept example printed on it and the other group which was presented cards with the name of the concept printed instead of a picture. The concept cards used in this task are depicted in Table 2. The S was introduced to the first two items, square and rectangle, and asked how they were alike. Next rhombus was presented and the S was then asked how this differed from the first two items and how they were all alike. This continued until all items were administered, with cube representing the contrast item.

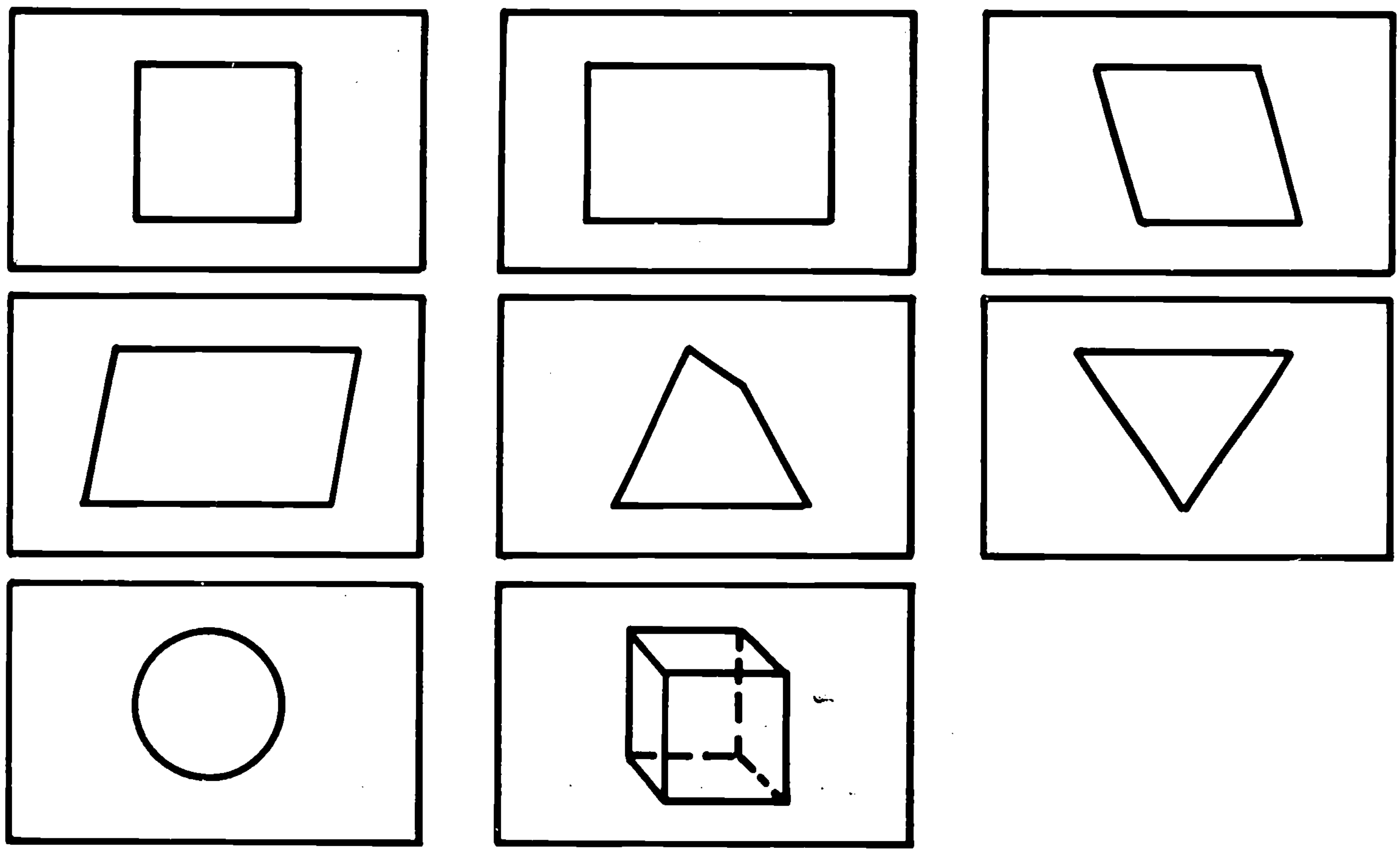
Rigney's experiment served as a prototype for the second task. The concepts here were the same as in the first task (with the exception of cube which was deleted), but a 26-picture array was constructed by using examples varying in size and orientation. Materials for the second task are shown in Table 3. The S constructed groups of pictures by selecting those figures that appeared alike to him in some way. After completing a group and having explained the rationale underlying the arrangement, the pictures were replaced in their original array so that another group could be formed. This process continued until the S had formed seven groups of pictures.

Responses on Tasks I and II were placed into categories resembling Olver's five bases of classification with some modification. The Perceptible, Nominal and Fiat categories were retained, while an

Table 2

Stimuli Used in Task I

PICTORIAL STIMULI



VERBAL STIMULI

SQUARE	RECTANGLE	RHOMBUS
PARALLELOGRAM	QUADRILATERAL	TRIANGLE
CIRCLE	CUBE	

Source: Wiviott, 1970, p. 115.

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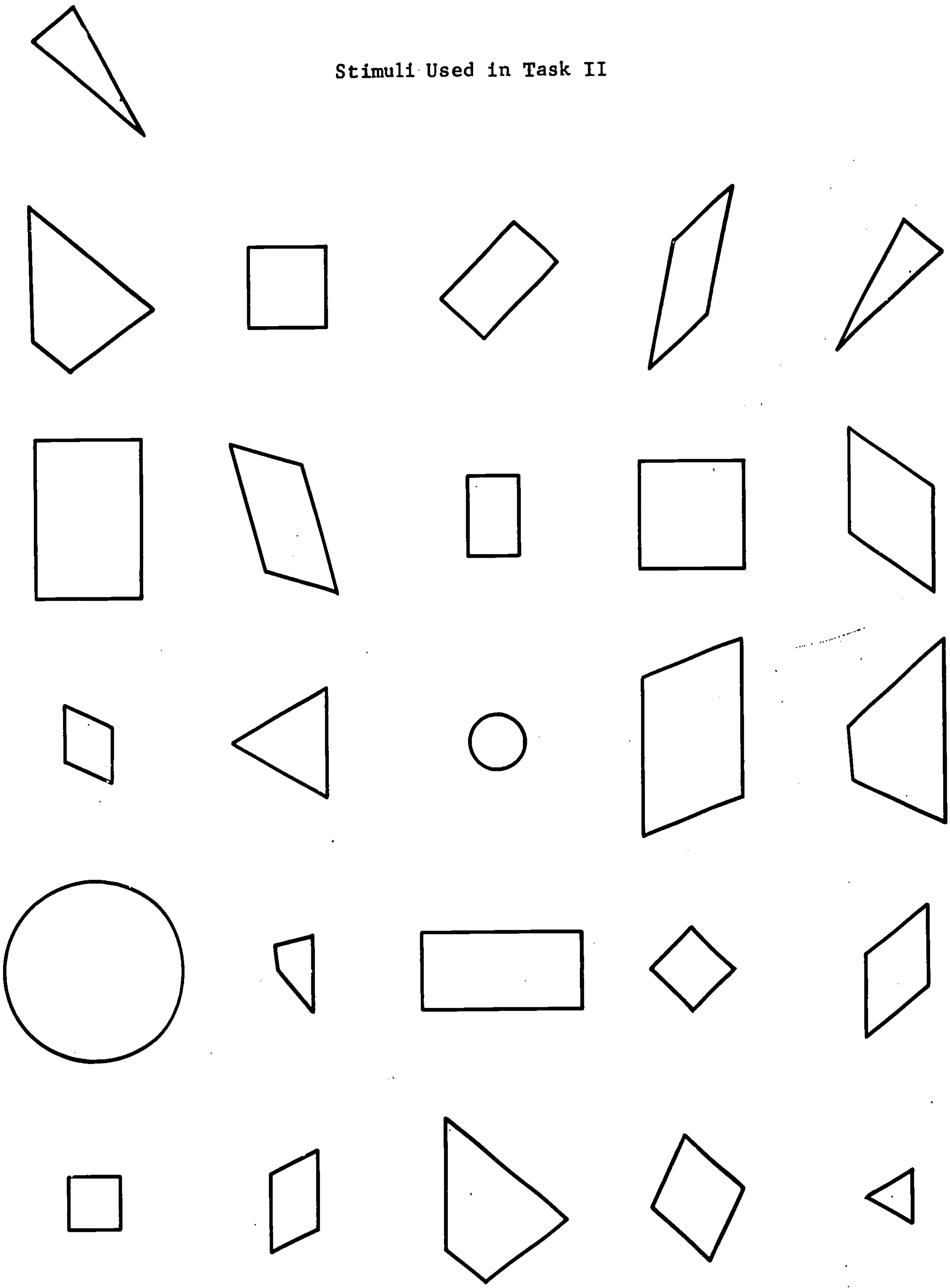
Table 3

Stimuli Used in Task II



Source: Wiviott 1970, p. 116.

Attribute category was inserted in place of Functional. The Affective category was dropped altogether. Table 4 describes the criteria for judging responses and gives some examples. Ninety-six subjects were used for the experiment with equal numbers from the fifth, eighth and eleventh grades.

The results revealed that grade level, achievement level and method of presentation had a significant effect on bases of classification. On both tasks, an increase in grade level was accompanied by a decrease in the use of perceptible-type responses, with attribute and nominal bases increasingly being relied upon. Higher achievers made fewer perceptible responses than low achievers, and Ss who were presented the pictorial stimuli gave more perceptible responses than those who were given the verbal material. The effect of sex on the bases of classification proved negligible. In addition, the percentage of correct responses was affected only by the achievement level; high achievers answered more correctly than did their counterpart low achievers. These differences, however, were small.

Thus, Wiviott's results accorded with her expectations that the development of classificatory behavior would follow an orderly pattern. The study substantiated findings of Olver and Rigney and the Bruner formulation with introduction of geometric material. Valuable information was also gained about the three stratifying variables.

Table 4

A System for Categorizing Task I and Task II Responses

1. Perceptible: The child may render the items equivalent on the basis of immediate phenomenal qualities, such as color, size, shape, or on the basis of position in time or space.

   Example: They are alike because they are both black figures on white cards.
   They are both printed in black ink.
   The lines are straight, not slanted.
   They are tilted to the right.
   This one is round.
   One is longer than the other.
   They are diamond-shaped.

2. Attribute: The child renders the items equivalent or diverse by naming a specific attribute of the concept.

   Example: They all have four sides.
   They are closed figures.
   They are plane figures.
   They are made of line segments.

3. Nominal: The child may group items by giving a name that exists ready-made in the language. A supraordinate concept name is used as the basis of grouping.

   Example: They are all parallelograms.
   They are diamonds.
   Both the square and the rectangle are rectangles.
   They are all geometric figures.

4. Subject-Fiat: The child may merely state that the items are alike or are the same without giving any further information as to the basis of his grouping, even when he is prodded.

   Example: They are alike.
   They are just different.

Source: Wiviott, 1970, p. 47.

Cultural Differences and Conceptual Development

The studies recounted above implicitly suggest that classificatory behavior develops in stages with some degree of universality. Heretofore, this review has not dealt with the impact of culture upon the growth of cognitive abilities, particularly with respect to classificatory behavior. It would certainly be naive to accept the notion that children from different cultures uniformly shift from color to form, from resemblance sorting to hierarchical classification, or from a perceptible basis to a functional basis of classification. Bruner's statement about the "impact of culture" ought to serve as a premonition in approaching cognitive phenomena.

> It goes without saying that different cultures provide different 'amplifiers,' at different times in a child's life. One need not expect the course of cognitive growth to run parallel in different cultures, for there are bound to be different emphases, different deformations. But many of the universals of growth are also attributable to uniformities in human culture. Cultural differences are not all that is produced by human culture. Cognitive growth, whether divergent or uniform across cultures, is inconceivable without participation in a culture and its linguistic community. [Bruner, et al., 1966, p. 2]

Thus, it is important to look at classificatory behavior in cultures other than our own to make inferences concerning the impact of culture.

One such study of classificatory behavior in another culture was carried out by Suchman (1966) who investigated the color-form preference of Moslem Hausa children in Zaria, Nigeria, West Africa. By administering three nonverbal sorting tasks requiring classification of abstract forms with instructions given in the native language, Suchman examined the developmental transition from color to form preference in Ss of ages 3-15. The results indicated that there was no developmental shift within the age span investigated, which suggested that the concept of a universal maturational process in color-form preference. must be modified or abandoned.

Maccoby and Modiano (1966) investigated the hypothesis that cultural traits affect the kinds of attributes preferred for equivalence grouping. They assigned classification tasks much like those developed by Olver (1961) to rural and urban Mexican children. Results showed that more than twice as many urban as rural children succeeded at the equivalance task. Urban Ss relied upon fewer perceptible attributes and resorted to more intrinsic functional and nominal bases of classification. The authors asserted that the explanation for this superiority of the urban child, who is more sophisticated linguistically and more abstract, lies in his urban surroundings. The urban school child is more inclined to manipulate concepts and to use his knowledge beyond the parameters of the school curriculum.

Greenfield, Reich, and Olver (1966) tested the generality of the urban-rural contrast with Alaskan Eskimos and Wolof Bush School children in Senegal. In Senegal, differences were found between the responses of rural and urban children which were parallel to the discoveries made by Maccoby and Modiano (1966) for Mexican children. City-living

Eskimos in Anchorage, on the other hand, showed continuity with other urban children studied. The dissimilarity between urban and rural children's performance was found to be analogous to a larger difference that divaricates children who have attended school and those who have not. The authors believed that, in the final analysis, the cause of poor performance in both cases was due to a severely limited exposure to problem solving and communication situations. Rural life, it seemed, was less conducive to the development of higher cognitive abilities. Results from unschooled Wolof children in the bush led the same authors to conclude also that an alleged "universal stage in conceptual development, complexive grouping, is less than universal and may be produced by school learning" [Greenfield, Reich, & Olver, 1966, p. 315]. Little variability in equivalence making emerges with unschooled children.

In another study, Evans and Segall (1969) gave Ss from urban, semiurban, and rural sections of Ganda two sorting tasks in which they were to group things alike on the basis of physical appearance and function. Both adults and children participated in these experiments, some of whom were schooled and others of whom were unschooled. The schooled children outperformed the unschooled children in learning to sort by function. Learning to sort in this manner was found to be most difficult for rural children and easiest for urban children. On the other hand, no differences between schooled children and unschooled children were revealed in learning to classify by color.

The authors suggested that the experience factor, particularly with regard to years of schooling and to a lesser extent with urbanization, was the critical one influencing classificatory ability.

Schmidt and Nzimande (1970) confirmed the significance of the experiential factor in classificatory behavior. Using children and adults Ss from Zululand in South Africa, they obtained significant differences between children in school and those not attending school, between literate and illiterate urban workers, and between illiterate urban and farm workers--favoring the former in each instance. Schooled children provided more classifications based on form, size, and number than did the unschooled children. Urban Zulu workers, particularly those who were literate (i.e., approximately 4-6 years of schooling), and rural Zulu children with schooling showed a distinct shift from color preference toward alternatives. Schmidt and Nzimande stressed the need in making cross-cultural comparisons to focus specific attention on the impact of the Western-type school in these countries. Regardless of the fact that these schools tend to be poorly equipped with teachers who have no more than 8-10 years of schooling themselves, they still present a cogent force in influencing the course of human cognitive development.

Based on the research affirming the critical influence of educational experience underlying conceptual development, Okonji (1970) attempted to train classification skills in 20 Nigerian Ibo children. The Ss, 11-12 years of age, were matched with a control group for age, years at school, SES, and pretest performance. The training consisted of four 40-minute sessions per week for four weeks. Ss were trained in classification with a color-form-size sorting task and were tested on a transfer task of animal sorting. The ability of the trained group to make more shifts than the control group in the sorting task was established as the success criterion since it was believed that "shifting" one's basis of grouping is indicative of the level of classificatory ability. A shift was considered to have occurred during the sorting tasks when a S formed new groupings unlike preceding ones using a different basis of classification. Okonji found that trained children made larger gains from pretest to posttest than untrained children, using more superordinate concepts in defining the basis for their grouping. However, no positive transfer was detected on the Kohs Blocks test which served as a supplementary remote transfer task.

The studies cited above seemingly dispel with some tenability the notion that classificatory behavior develops uniformly across cultures. Though a purely maturational position appears tenuous on the basis of these studies, the last cross-cultural investigation to be reported here presents results supporting such a position.

Price-Williams (1962) administered a number of tasks which involved classifying local plants and animals to children, 6 1/2 to 11 1/2 years of age, of the Tiv tribe in Nigeria. He found that both schooled and unschooled Nigerian children followed the developmental trends set forth by Inhelder and Piaget, although they attained the various stages at slightly later ages than European children.

In summary, the studies relating culture to classificatory behavior reviewed in this section point out that something more than chronological age underlies conceptual development. The research suggests that some minimal degree of schooling is essential for moving from a rudimentary basis of classification to the higher-order bases. The implication for this study is that environmental factors as well as maturation level may determine the level and growth rate of classificatory skills among low socioeconomic children.

Age Differences and Conceptual Development

In the literature reviewed in the first section of this chapter, we found some evidence of a relationship between age and classificatory development. These studies have frequently indicated that American children change from concrete and perceptible bases of grouping to functional bases at about the age of six. To extend this discussion of age as a factor in the development of equivalence formation, several additional studies will be reported.

Vinacke (1952) summarized a substantial number of early findings on concept formation in The Psychology of Thinking and concluded that children's concepts change with increasing age. He believed, however, that the change occurred in the pattern of a gradual progression rather than in sudden definite stages. Conceptualizing ability appears to develop from simple to complex levels, and the greatest difference between the concepts of children and those of adults results from the wider experience and knowledge of adults.

Goldman and Levine (1963) inquired into the development of modes of concept formation when the stimuli to be conceptualized were familiar objects. Their study concentrated on two important features of conceptual development, individuation and hierarchic integration. Male Ss ranging widely in age and educational experience were drawn from kindergarten, first, second, fourth, sixth, and ninth grades, college and scientific backgrounds. All Ss were asked to perform the Goldstein-Scheerer Object Sorting Test which is divided into two parts: "active sorting" and "passive sorting." Three scores are derived from the test: (a) Part-whole Relationships (determines whether or not the concept offered by the S encompasses all or part of the stimulus objects), (b) Concepts (refers to the rationale provided for the sorting), and (c) Formal Characteristics (considers multiple criteria, repetitions, and number of objects sorted). Results showed developmental changes in part-whole scores and in types of concepts used. These changes suggested a shift from classifications based upon an immediate, experiential link to the environment to conceptual bases transcending perceptual links.

Investigating developmental trends in the abstraction ability of children, Sigel (1953) tested 60 white lower-middle class children aged 7, 9, and 11 years. Five test situations were administered to each child which included familiar toy objects, pictures of these toys, and the names of these toys. His data revealed that regardless of the stimulus used, perceptual bases of classification declined with age and conceptual bases increased. Seven-year-old children grouped predominantly on thematic bases, nine-year-old children on perceptual and conceptual bases with some miscellaneous categories, and eleven-year-old children primarily on conceptual bases. Sigel's findings supported the hypothesis that classificatory behavior changes with age. Similar developmental changes may be likely to occur in the present study. Low SES Ss are expected to shift from a perceptual basis of classification to a more conceptual basis with increasing age.

Sex Differences and Conceptual Development

A compendious review of the research dealing with sex differences in cognitive functioning has been presented by Anastasi (1958). While females generally are observed to be superior to males on tasks requiring rapid perception of details, males excel in spatial orientation.

In verbal functioning, girls tend to speak earlier than boys and have larger vocabularies during the preschool years. This trend continues throughout the elementary and high school level in other aspects of verbal ability as well--in reading speed, understanding of analogies, sentence completion, and dissected sentences. More recent studies using multiple-factor batteries indicate that in word fluency and language usage girls are favored, but findings tend to be negligible and inconsistent where verbal comprehension and verbal reasoning tests are concerned. Anastasi posits two hypotheses to explain female verbal pre-eminence: the precocious physical development of girls might account for their rapid advancement in articulation; and, the nature and extent of their contact with the mother, who plays an instrumental role in language training in the home, might aid in this verbal development.

Girls also tend to be superior on memory tests, but the findings do not signify a difference of the same magnitude as for verbal functioning.

Tests of numerical aptitude show a male superiority which begins to appear only when children are well into elementary school. Males perform consistently better on numerical reasoning tests, whereas females excel over males on tests measuring speed and accuracy in computation.

And lastly, Anastasi summarizes discoveries related to school achievement tests which disclose a male predominance in science, social science, and arithmetic reasoning; and a female edge in spelling, language usage, and arithmetic computation.

Sex differences in conceptual behavior have been reported, but are inconsistent. Honkavaara (1958) cited evidence that in children 7-11 years of age, girls make more use of form for classifying stimuli than boys. In a replication of this same experiment with younger children, ranging in age from 3 1/2 to 8 1/2 years, Kagan and Lemkin (1961) obtained similar findings. Presenting paper cutouts of geometric figures which differed in color, shape, and size, they found no significant overall sex differences. However, when subjects were divided into older and younger age groups, sex differences were apparent for the older group only; the older boys showed a preference for color, while the older girls showed a preference for form. Kagan and Lemkin suggested that this sex difference might be attributed to the early development of verbal skills in young girls, since the language labels for the geometric forms (square, triangle, circle) were used more often by girls than boys.

In another study, Lowery and Allen (1970) conducted an experiment with children at the first grade level to examine their performance on several dimensions of "resemblance sorting," the lowest level of Piaget's classificatory scheme. Their Ss were divided into three SES levels: upper, average and lower. Applying the Visual Resemblance Sorting Test (VRST) as the criterion measure, females for the most part showed higher mean scores than males.

Harris, Schaller, and Mitler (1970), however, found no evidence of sex differences in sorting behavior. Performance on a color-form sorting task did not differ between boys and girls in any of the age groups studied--kindergarten, first grade, and third grade. Harris, Schaller, and Mitler suggested that girls would have an advantage in performing classificatory tasks only when those tasks required significant language skill.

As noted earlier, Wiviott (1970) also failed to detect differences in bases of classification as a function of sex. The lack of sex differentiation in her study might have been the consequence of using older Ss and using tasks drawing on language usuage and spatial orientation, one ability more prevalent in females, the other in males.

Generally speaking, females demonstrate greater proficiency in perception of details, verbal functioning, language usage, and arithmetic computation, whereas males do better in spatial orientation, arithmetic reasoning, and science. These cognitive abilities may make differential contributions to performance on classificatory tasks, depending on the nature of the specific task. Since Wiviott's study was one of the few which failed to detect sex differences in classificatory behavior, it is important to determine whether this result can be replicated.

Achievement Level and Conceptual Development

The role which intelligence plays in conceptual thinking abilities has always been difficult to appraise. While some investigators have emphasized that intelligence and concept formation are closely linked, there has been very little evidence put forth to verify this assumption.

Osler (Osler & Fivel, 1961; Osler & Trautman, 1961) carried out several investigations to determine the relationships between intelligence level and concept attainment. In one study, (Osler & Fivel, 1961) Osler found that when children worked on the acquisition of concepts of animals and living things, higher IQ Ss (mean IQ = 121) made a smaller mean number of errors in attaining criterion than the normal IQ Ss (mean IQ = 102). There were also more Ss in the high IQ group reaching criterion than in the low IQ group. Thus, intelligence was found to be significantly related to number of errors to criterion and number of successful Ss.

In another study (Osler & Trautman, 1961), Osler hypothesized that Ss of superior intelligence attain concepts through hypothesis testing, while Ss of normal intelligence rely upon S-R associative learning to attain concepts. Testing the validity of this assumption, an experiment was devised where Ss in high (mean IQ = 120) and normal (mean IQ = 101) IQ groups were examined on a concept attainment task. The concept studied was the number "two"." Half of the Ss within each IQ group were presented complex exemplars, and the other half were presented simple exemplars. Since the complex stimuli would generate more hypotheses than the simple ones, it was believed that they would slow down the superior group's performance without affecting the normal group.

The results indicated that Ss of superior IQ encountered more difficulty with the complex exemplars than the simple ones, while the Ss of normal IQ had equal difficulty with both types of stimuli. The prediction was therefore confirmed. The investigators concluded that the superior Ss lost all advantage of high intelligence with the complex stimuli.

Williams and Blake (1969) examined intellectual differences among retarded, normal, and superior groups of children utilizing verbal classification material. All tasks were administered orally to Ss in small groups of 4-10 children. When the retarded, normal, and superior Ss were equated for mental age (MA), their performances did not differ appreciably from one another on classification tasks dealing with the grouping of items by initial letter. Some differences occurred among the three groups when equated for chronological age (CA). The superior intelligence group responded more accurately in classification than the normal and retarded groups, while the normal and retarded intelligence groups responded with similar accuracy.

In a study of multiple-categorization ability, Edwards (1969) investigated the effects of intellectual ability as measured by the Pintner-Cunningham Primary Test on categorizing of objects. He found that first grade male Ss of different IQ levels did not differ significantly in the frequency of their use of relational or analytic concepts. However, the higher IQ Ss made significantly more categorizations than either the moderate or low IQ subjects, and the high IQ Ss made significantly greater use of inferential-categorical concepts as the basis for grouping the test stimuli than the low IQ subjects.

Freyberg (1966) looked at the relationship between children's level of concept development and their school achievement in the areas of arithmetic computation, arithmetic problem-solving, and spelling. 151 children, ages 6-9 years, were given a 72-item objective test of concept development which included tests of conservation, numerical correspondence, and concepts of position in space, speed, age, kinship, and causal relationships. IQ scores (Primary Mental Abilities) for Ss ranged from 77-133 with a mean of 104.

Freyberg found the correlation between concept scores and mental age (.52) to be greater than that with chronological age (.12). The results demonstrated that conceptual development is more intimately intertwined with general intellectual ability than with chronological age. However, it also appeared that children's school performance is

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a concomitant of concept learning in ways not adequately assessed by traditional intelligence tests.

In summary, there are some aspects of intelligence ostensibly connected with conceptual thinking. The use of conventional appraisal instruments for IQ have not, however, sufficiently explained or identified the phenomenological character of conceptual development. Perhaps by differentiating between high and low achievement groups in the present study some additional information about these differences may be gained. It is conceivable that high achievers shift from concrete to abstract bases of classification at an earlier age than low achievers.

Socioeconomic Status and Conceptual Development

This section reports a number of studies probing the role of social class in cognitive growth. Not all of these studies concur in their conclusions, but the majority indicate that high SES children are better at problem solving than low SES children.

Siller (1957, 1958) compared the conceptual abilities of white middle class and white lower class urban school children by examining two variables: form of symbolism and proneness to abstract. His sixth-grade Ss were comprised of a group of middle class children from a middle class school and a group of lower class children from a lower class school. Socioeconomic status was determined by free lunch data and a questionnaire filled out by the parents. Tests of classification, analogies, and abstract-concrete similarities were used for evaluating conceptual level.

The test results showed that higher socioeconomic children performed better than lower socioeconomic children on all of the conceptual ability tests,with greatest differences being evinced on the verbal material. When high and low socioeconomic Ss were matched according to non-verbal scores and compared on the verbal tests, the high SES Ss excelled over the low SES subjects. Moreover, high SES Ss still outperformed the low SES Ss on non-verbal tests when the two groups were matched on the basis of verbal scores. Siller found considerable overlapping in his two groups, however, and observed that only a small number of Ss in the low SES group accounted for the observed differences.

Burnes (1970) tested black and white boys from lower class and upper-middle class homes on the WISC in order to ascertain group patterns of intellectual abilities. Her sample was composed of the following groups: (1) 18 upper-middle class blacks, (2) 20 upper-middle class whites, (3) 20 lower class blacks, and (4) 20 lower class whites. No differences were observed between the two racial groups; but significatnt verbal IQ, performance IQ, and full-scale IQ differences were found between socioeconomic levels.

The interaction between family social status and selected Piagetian science concepts was studied by Lepper (1967). Four subscores (source of income, occupation, education, and religious affiliation) of the McGuire-White index were related to conservation task performance of black and white first graders. The tasks were designed after those developed by Piaget and his co-workers. It was found that differences existed between the black and white subjects on the science-related concepts. Lepper asserted that these differences were due to the dissimilarity in the Ss' backgrounds rather than innate racial differences. On the experience-based tasks of number, length, and area, white children were superior to black children in their performance;

nevertheless, both groups performed equally well on the less experience-based tasks. It was concluded that the SES index employed was inutile since the subjects were not matched on aspects of their backgrounds important to the attainment of these conservation concepts.

Raven (1967) explored the development of classificatory abilities in culturally disadvantaged children. Six classification tests corresponding to the tasks of Inhelder and Piaget were given to middle class and lower class children, ages 6, 8, and 10 years. The tests consisted of exhaustive sorting, dual class membership, whole is sum of its parts, conservation of hierarchy, horizontal reclassification, and quantitative inclusion.

Raven found differences between the middle and low socioeconomic groups on the Piagetian tasks, and these differences increased with age and degree of task complexity. Culturally disadvantaged children performed less well than middle class children in operating with categorical relationships. It was suggested that these differences are attributable to perceptual and language disparities in the two socioeconomic groups which might be attenuated through a training program.

Findlay and McGuire (1957) hypothesized that if children of dissimilar socioeconomic background were matched on IQ, lower class children might do significantly better than middle class children on sorting tasks. They hypothesized that the lower class child, whose IQ is equivalent to the middle class child, might be "genetically" brighter but his performance is hindered by the cultural bias of the test. To test this proposition, low and middle SES children selected on the basis of the Index of Status characteristics (ISC) were examined on block-sorting problems involving concepts of equal familiarity to the two groups.

Despite the similarity of IQ (as measured by the California Test of Mental Maturity), the middle SES Ss performed significantly better than the low SES Ss, disaffirming the authors' hypothesis and suggesting an effect due to social class independent of intellectual ability.

In another study which touched directly upon classificatory behavior, Sigel, Anderson, and Shapiro (1966) compared black middle class preschool children with black lower class preschool children on sorting tasks of familiar items. Their results disclosed that middle class children preferred physical attribute and use relationships in their grouping, whereas the lower class group was inclined more toward use and thematic relationships. Although differences existed between the social class groups, there was considerable variability within each of the social classes. The authors conjectured that other factors, including sex differences and IQ, may play a role as well as the SES factor.

As mentioned previously, however, not all studies have found a significant relationship between SES and cognitive functioning. Estes (1956), for example, tested 4, 5, and 6 year old children on Piagetian problems dealing with mathematical and logical concepts and found no differences between the performances of low and middle class Ss.

Karp, Silberman, and Winters (1969) evaluated the hypothesis that field dependence and related cognitive abilities do not vary with socioeconomic level. They administered six subtests of the WISC (three verbal and three performance) to middle and lower class boys, along with a measure of field dependence (Embedded Figures

Test-- EFT) and a test of sophistication-of-body concept. Two male adult groups given the EFT were included in a second study. The authors' hypothesis was generally upheld by both child and adult samples. While middle class boys scored significantly higher than the lower class boys on verbal comprehension subtests, which are unrelated to differentiation, the other tests reflected no significant differences between the two SES groups. The only exception was on Block Design, where the means for the two social class groups were significantly different.

Tagatz, Layman, and Needham (1970) looked for possible differences in positive and negative information processing as a function of socioeconomic background. They found no differences in the performance of high and low SES children at the third and fourth grade levels. It was concluded that since Ss from both groups attended the same school, initial differences among children from different socioeconomic backgrounds may have vanished as a consequence of continual interaction. If so, disadvantages due to low social class might be compensated by exposure to peers who have profited from broader experiences. The authors' speculation seems to have enough plausibility to warrant further investigation along these lines. Many SES comparative studies, for instance the one of Siller (1957, 1958) cited above, have examined performance of children from high SES schools with that of children from low SES schools.

In summary, there is some disagreement in the literature concerning the effect of social class on cognitive learning. The weight of the evidence seems to indicate that true differences do exist.

In the present experiment, it is expected that the change from perceptible to attribute and nominal bases of classification will occur at a later age than that noted by Wiviott (1970), since the subjects will be of lower socioeconomic status.

Chapter 3

EXPERIMENTAL METHOD

The purpose of this experiment was to determine the relationship of method of presentation, grade level, achievement level, and sex to the various bases upon which children of low socioeconomic background classify geometric concepts.

Hypotheses: This study tested the following propositions based primarily on the findings of Wiviott (1970):

(i) Low SES children in grades 5, 8, and 11 differ in their bases of classifying geometric figures. At the lower grade levels, children's categorizing involves more perceptible responses than does children's categorizing in the upper grades. Conversely, children in the upper grades use more attribute and nominal responses than children in the lower grades.

(ii) Low SES children of high and low achievement differ in their bases of classifying geometric figures. Low achievers give more perceptible responses than high achievers, while high achievers give more attribute and nominal responses than low achievers.

(iii) Low SES boys and girls do not differ in their bases of classifying geometric figures.

(iv) Verbal and pictorial methods of presentation have a significant effect on the bases of classifying geometric figures used by low SES children. A pictorial presentation elicits more perceptible responses than a verbal presentation.

(v) The total number of correct classifications differs only as a function of achievement level. High achievers give more correct responses than low achievers.

Subjects

Ninety-six disadvantaged students from the Beloit School District in Wisconsin served as Ss in this study. They were selected from the fifth, eighth, and eleventh grades--32 Ss at each level. Fifth graders were drawn from six Title I schools, eighth graders from an intermediate school, and eleventh graders from a high school. All schools are situated within Beloit, an urban industrial area of medium size (population 35,256).

Potential Ss were initially chosen by the respective school principals with the assistance of school counselors. School personnel identified between 60-80 children at each grade level exemplifying characteristics believed to be reflective of a low socioeconomic background. Next, the head of household in the homes of each of these children was rated on the Warner (1960) 7-point occupation scale. Occupation was the sole criterion for SES since information concerning family income and education level was unavailable. Students assigned ratings in the 6-7 category were judged to be suitable for the present study; the few who received ratings below 6 were removed from consideration. Thus, Ss in this study were from families in which the head of the household was a semi-skilled worker, unskilled worker, or unemployed.

Subjects were then stratified at each grade level by sex and mathematics achievement level within sex. A high and low achievement group was designated, based upon the median for each sex. Consequently, male and female Ss who had scored above the median for their sex were assigned to a high achievement group, and those who had performed below the median were assigned to a low achievement group.

To determine mathematics achievement level, standardized achievement test scores were obtained from the schools. The Stanford Achievement Test (Kelley, Truman, Madden, Gardner & Rudman, 1964) served for bifurcating students from the fifth and eighth grades. Arithmetic Concept and Arithmetic Application scores were averaged together for these students. For eleventh graders, Quantitative Thinking scores were used from the Iowa Tests of Educational Development (Lindquist & Feldt, 1963).

After the students were stratified according to sex and mathematics achievement level, eight Ss were randomly selected for each achievement by sex cell, for a total of 32 Ss at each grade level. Within each of the cells, Ss were randomly assigned to one of two treatment groups: pictorial or verbal. Thus, there were four Ss in each possible combination of achievement level, sex, and method of presentation for fifth, eighth, and eleventh grades. Table 5 gives the median mathematics achievement scores for the Ss in each experimental group of the study.

Experimental Materials

The materials used in this experiment were the same as in the study of Wiviott (1970). The first task consisted of a sequential presentation of eight geometric concept cards making up the array of: square - rectangle - rhombus - parallelogram - quadrilateral - triangle - circle - cube. Half of the Ss were presented cards with pictures showing instances of each concept (pictorial treatment). The other half (verbal treatment) received only the name, of the concepts (e.g., "square," "rectangle," etc.) The cards measured 4" x 6" and were inscribed in black ink. The cards used in Task I are portrayed in Table 2 (page 20).

The second task required free sorting of concept examples. A 26-picture array depicted geometric concept instances varying along the irrelevant attributes of size and orientation. The

Table 5

Median Mathematics Achievement Percentile Scores
for Subjects in Each Experimental Group

Grade	Achievement	Sex	Pictorial	Verbal
5	High	Male	29.50	24.50
		Female	20.75	17.75
	Low	Male	8.0	6.25
		Female	2.75	6.25
Across Achievement & Sex			9.75	10.0
8	High	Male	41.0	49.50
		Female	32.50	36.0
	Low	Male	18.25	9.50
		Female	28.50	12.50
Across Achievement & Sex			29.50	23.50
11	High	Male	59.50	56.0
		Female	40.0	51.50
	Low	Male	25.50	25.0
		Female	13.50	18.0
Across Achievement & Sex			36.0	36.0

concepts were the same as in the first task with the exception of cube. Again, 4" x 6" cards printed with black ink were used. The 26-card array employed in the second task is illustrated in Table 3 (page 21).

Procedure

Tasks I and II were administered consecutively to each S under individual testing conditions lasting about 15–30 minutes. Testing was conducted in private rooms in each of the schools. Responses of Ss in Task I were recorded on audiotape, while a verbatim written record was kept in Task II of the cards selected for each sort and the responses given regarding the basis for sorting. A copy of the instructions given to each S comprises Appendix A.

Procedures for the first task were patterned after the studies of Olver (1961) and Wiviott (1970). The first two cards (square and rectangle) were placed on a table before the S, and he was asked to explain how the two were alike. The third card (rhombus) was then presented and the S was asked to explain how it differed from the first two, and how they were all alike. This procedure continued until all cards were administered with cube functioning solely as a contrast item. In all, there were six questions involving likenesses and six questions involving differences between stimuli. For Ss in the verbal condition, the names of concepts were routinely pronounced, but names of concept instances in the pictorial condition were withheld from the Ss. Questions asking for clarification of the procedure were answered.

Immediately following Task I, the 26-picture array for Task II was given. The format of this free-sort exercise was modeled after the studies of Rigney (1962) and Wiviott (1970). The cards were laid out on a table before the S in the order shown in Table 3. Each S was directed to examine the cards closely, to form a group of pictures which seemed alike in some way, and to tell the basis for his grouping. After the response was recorded, the S was requested to form another group, continuing the procedure until seven groups of pictures had been obtained. Ss were not informed of how many of these groups were needed. If a S stopped prematurely, he was asked to continue his selections until completion of the task. Again, questions concerning the procedure were answered.

Treatment of the Data

All responses were categorized using Wiviott's (1970) four bases of classification: Perceptible, Attribute, Nominal, and Subject-Fiat. The Fiat category was used in the first task only since Wiviott noted that it was rarely applied in a free sort exercise. Table 4 (page 23) describes the criteria for judging responses utilized in the present study.

In Task I, responses concerning similarities were tabulated separately from responses concerning differences. The total number of correct responses for each task was also calculated. The experimenter made judgments as to the accuracy of classification for each subject's response.

Experimental Design

Method of presentation (verbal or pictorial) was the independent variable in this experiment. Grade level (5, 8, or 11), sex (male or female), and mathematics achievement level (high or low) within grade level and sex were included as stratifying variables. The resulting 2 x 3 x 2 x 2 nested design is illustrated in Table 6.

Statistical Analysis

The total number of responses in each classification category (Table 4, page 23) for Tasks I and II and the total number of correct responses on these two tasks constituted the dependent variables for this experiment.

To test hypotheses i, ii, iii, and iv, multivariate analyses of variance (MANOVAs) were performed. The first analysis, a 2 x 3 x 2 x 2 MANOVA, embodied method of presentation on Task I, grade level, sex, and achievement within grade level and sex as factors. The dependent variables for the analysis were two linear contrasts among three of the original variables summed over likeness and difference responses. The contrasts were as follows:

A. The number of perceptible responses minus the average

Table 6

Experimental Design of the Experiment

	5				8				11			
	M		F		M		F		M		F	
	H	L	H	L	H	L	H	L	H	L	H	L
Verbal	S_{1}	S_{9}	S_{17}	S_{25}	S_{33}	S_{41}	S_{49}	S_{57}	S_{65}	S_{73}	S_{81}	S_{89}
	S_{2}	S_{10}	S_{18}	S_{26}	S_{34}	S_{42}	S_{50}	S_{58}	S_{66}	S_{74}	S_{82}	S_{90}
	S_{3}	S_{11}	S_{19}	S_{27}	S_{35}	S_{43}	S_{51}	S_{59}	S_{67}	S_{75}	S_{83}	S_{91}
	S_{4}	S_{12}	S_{20}	S_{28}	S_{36}	S_{44}	S_{52}	S_{60}	S_{68}	S_{76}	S_{84}	S_{92}
Pictorial	S_{5}	S_{13}	S_{21}	S_{29}	S_{37}	S_{45}	S_{53}	S_{61}	S_{69}	S_{77}	S_{85}	S_{93}
	S_{6}	S_{14}	S_{22}	S_{30}	S_{38}	S_{46}	S_{54}	S_{62}	S_{70}	S_{78}	S_{86}	S_{94}
	S_{7}	S_{15}	S_{23}	S_{31}	S_{39}	S_{47}	S_{55}	S_{63}	S_{71}	S_{79}	S_{87}	S_{95}
	S_{8}	S_{16}	S_{24}	S_{32}	S_{40}	S_{48}	S_{56}	S_{64}	S_{72}	S_{80}	S_{88}	S_{96}

number of attribute and nominal responses $(P - \overline{A + N})$.

B. The number of attribute responses minus the number of nominal responses (A-N).

The rationale for creating the first contrast was to determine any differences in the use of the lower-order Perceptible category the higher order Attribute and Nominal categories. The second contrast was included so that differences in the use of the two higher-order categories, Attribute and Nominal, could be scrutinized more closely.

The contrasts which served as the dependent variables for the second multivariate analysis compared interactions between likeness and difference in Task I as follows:

A. The number of perceptible difference, attribute and nominal likeness responses minus the number of perceptible likeness, attribute and nominal difference responses (Interaction 1).

B. The number of attribute difference, nominal likeness responses minus the number of attribute likeness, nominal difference responses (Interaction 2).

The use of these contrasts as dependent variables enabled the testing of interactions of the bases of classification with the independent variable when likeness and difference responses were considered.

A univariate analysis of variance with the orthogonal contrast of likeness minus differences for the Subject-Fiat category was carried out for Task I. The dependent variable for this analysis was the number of Subject-Fiat responses elicited from Ss when they were asked to describe similarities between stimuli minus the number of Subject-Fiat responses elicited when asked to describe differences between stimuli (S Like-S Diff).

A multivariate analysis of variance with method of presentation, grade level, sex, and mathematics achievement level within grades and sex as factors was also performed for Task II. The dependent variables in this analysis were linear contrasts among three of the original variables. The contrasts were as follows:

A. The number of perceptible responses minus the average number of attribute and nominal responses ($P - \overline{A + N}$).

B. The number of attribute responses minus the number of nominal responses (A - N).

To test hypothesis v, the total number of correct responses was calculated for each subject on Tasks I and II and univariate analyses of variance were carried out to determine the effects of method of presentation, grade level, sex, and achievement within grade and sex.

Chapter IV

RESULTS AND DISCUSSION

Results of the present study are reported in this chapter according to task. The results and discussion of Task I are presented first, including the analyses of bases of classification used and the total number of correct responses made. An account of Task II immediately follows with similar handling of the data. Lastly, findings of the present study concerning grade level, achievement level, sex, and method of presentation are compared to those of Wiviott (1970).

Task I

Each response given by a subject was categorized as Perceptible (P), Attribute (A), Nominal (N) or Subject-Fiat (S). A total of twelve responses was recorded for each S: six from questions involving likenesses and six from questions involving differences between the stimuli. To illustrate the scoring procedure for Task I, suppose an attribute response was elicited when a S was asked about differences between stimuli; that response would be marked as an Attribute Difference (A Diff) response. Likewise, if a S made a perceptible response when questioned about likenesses among various stimuli, it would be entered as a Perceptible Likeness (P Like) response.

An inter-rater reliability check was performed on a random sample of twenty-four protocols, one S from each cell. The protocols were scored by an independent rater using the scoring format outlined previously in Table 4 (p. 23). The percentage of agreement between the two independent ratings was 88.2% for the response data on Task I.

The mean number of responses in each classification category as a function of grade level, achievement level, and sex for the pictorial and verbal presentation groups is shown in Table 7. The number of responses in each category for individual Ss can be found in Appendix B.

For the first multivariate analysis of variance in Task I, the Perceptible, Attribute, and Nominal categories describing likenesses and differences between stimuli were linearly combined into two orthogonal contrasts. In the first contrast, the average number of responses in the Attribute and Nominal categories was subtracted from the number of responses in the Perceptible category, resulting in the dependent variable $P - \overline{A + N}$.

The other contrast was formed by taking the difference between the Attribute and Nominal categories, forming the dependent variable A-N.

Table 7

Means and Standard Deviations of the Number of Responses in Each Classification Category as a Function of Grade, Achievement Level, Sex, and Method of Presentation for Task I

Achievement Level	Sex	Treatment	P Diff	A Diff	N Diff	S Diff	P Like	A Like	N Like	S Like
			Grade 5							
High	Male	Pictorial	4.25 (.83)	.50 (.50)	1.25 (.83)	0 (0)	1.0 (1.22)	3.25 (1.48)	.75 (.83)	1.0 (1.22)
		Verbal	3.25 (1.64)	2.0 (1.58)	.25 (.43)	.50 (.50)	2.25 (1.92)	2.0 (1.58)	1.75 (2.05)	0 (0)
	Female	Pictorial	3.25 (.43)	1.50 (.12)	1.25 (.83)	0 (0)	.25 (.43)	4.0 (1.73)	1.25 (2.17)	.50 (.50)
		Verbal	3.75 (1.48)	2.0 (1.58)	.25 (.43)	0 (0)	3.75 (1.92)	2.0 (1.87)	.25 (.43)	0 (0)
Low	Male	Pictorial	2.50 (.87)	2.50 (.50)	.75 (.43)	.25 (.43)	1.0 (1.22)	4.50 (1.50)	.50 (.87)	0 (0)
		Verbal	2.50 (1.50)	3.0 (1.22)	.50 (.86)	0 (0)	1.75 (1.09)	2.75 (1.09)	1.50 (.50)	0 (0)
	Female	Pictorial	3.25 (1.09)	1.25 (1.09)	1.25 (.83)	.25 (.43)	.25 (.43)	4.0 (1.22)	.75 (1.30)	1.0 (1.0)
		Verbal	3.0 (1.58)	2.50 (1.12)	.50 (.50)	0 (0)	1.50 (1.50)	4.50 (1.50)	0 (0)	0 (0)
Fifth Grade Mean			3.22	1.91	.75	.13	1.47	3.38	.84	.31

Note. - Standard deviations are given in parentheses.

Table 7 (continued)

Grade 8

Achievement Level	Sex	Treatment	P Diff	A Diff	N Diff	S Diff	P Like	A Like	N Like	S Like
High	Male	Pictorial	3.25 (1.30)	2.25 (1.09)	.50 (.87)	0 (0)	1.0 (1.22)	4.75 (1.30)	0 (0)	.25 (.43)
		Verbal	2.75 (1.92)	3.0 (1.87)	.25 (.43	0 (0)	1.0 (1.0)	4.50 (1.66)	.50 (.87)	0 (0)
	Female	Pictorial	2.75 (1.09)	2.75 (1.09)	.50 (.50)	0 (0)	.25 (.43)	5.25 (.83)	0 (0)	.50 (.87)
		Verbal	2.0 (.71)	2.75 (1.48)	.25 (.43)	1.0 (1.22)	1.25 (1.64)	2.25 (1.92)	2.0 (1.73)	.50 (.37)
	Male	Pictorial	2.0 (1.22)	2.50 (2.06)	1.50 (1.12)	0 (0)	1.50 (1.66)	3.75 (2.49)	.25 (.43)	.50 (.87)
		Verbal	2.0 (1.58)	2.50 (1.12)	0 (0)	1.50 (1.12)	1.0 (.71)	2.25 1.92)	.50 (.87)	2.25 (1.92)
	Female	Pictorial	2.75 (1.79)	1.50 (1.12)	1.75 (1.48)	0 (0)	.75 (1.30)	3.75 (.83)	1.0 (1.22)	.50 (.87)
		Verbal	3.0 (1.87)	2.50 (1.50)	0 (0)	.50 (.87)	.50 (.87)	3.0 (2.12)	1.0 (1.73)	1.50 (1.50)
Eighth Grade Mean			2.56	2.47	.59	.38	.91	3.69	.66	.75

Table 7 (continued)

Grade 11

Achievement Level	Sex	Treatment	P Diff	A Diff	N Diff	S Diff	P Like	A Like	N Like	S Like
	Male	Pictorial	3.25 (.83)	2.0 (1.22)	.75 (.83)	0 (0)	.50 (.50)	4.25 (.83)	.50 (.83)	.75 (.83)
		Verbal	2.25 (2.28)	2.25 (1.92)	.50 (.50)	1.0 (1.22)	2.25 (2.28)	1.50 (2.60)	1.50 (2.06)	.75 (1.30)
	Female	Pictorial	3.0 (1.22)	1.25 (.83)	1.50 (.87)	.25 (.43)	.75 (.83)	3.25 (2.17)	1.25 (1.64)	.75 (.83)
		Verbal	3.25 (1.48)	1.75 (1.48)	.25 (.43)	.75 (.43)	1.25 (1.09)	4.0 (1.87)	.25 (.43)	.50 (.87)
	Male	Pictorial	2.75 (2.28)	1.25 (1.30)	1.50 (1.12)	.50 (.50)	.25 (.43)	3.75 (1.79)	.25 (.43)	1.75 (1.48)
		Verbal	3.0 (1.87)	1.75 (1.79)	.50 (.50)	.75 (.83)	1.25 (1.30)	3.0 (2.24)	1.75 (1.79)	0 (0)
	Female	Pictorial	2.25 (.43)	1.50 (1.12)	2.25 (1.48)	0 (0)	2.25 (1.48)	1.50 (1.66)	2.25 (2.49)	0 (0)
		Verbal	3.75 (1.92)	1.75 (1.30)	.25 (.43)	.25 (.43)	1.75 (1.79	2.50 (2.06)	1.0 (1.0)	.75 (1.30)
Eleventh Grade Mean			2.94	1.69	.94	.44	1.28	2.97	1.09	.66

Utilizing contrasts as dependent variables permitted the testing of interactions of the bases of classification with the independent variables of grade level, achievement level, sex, and method of presentation.

The second multivariate analysis of variance also used two linear contrasts as the dependent variables. However, in this analysis likeness and difference scores were taken into account when examining the interactions of the bases of classification with the independent variables. The first dependent variable was derived by taking the number of responses in the Perceptible Difference, Attribute and Nominal Likeness categories minus the number of responses in the Perceptible Likeness, Attribute and Nominal Difference categories (P Diff, A, N Like-P Like, A, N Diff, hereafter called Inter 1). The second dependent variable was produced by taking the difference between the Attribute Difference, Nominal Likeness categories and the Attribute Likeness, Nominal Difference categories (A Diff, N Like-A Like, N Diff, hereafter called Inter 2).

Lastly, a univariate analysis of variance was performed for the Subject-Fiat category, using the linear contrast between likeness and difference responses as the dependent variable (S Like-S Diff). This contrast was incorporated for the testing of differences between the number of Subject-Fiat responses given on the likeness and difference subtasks as a function of grade, achievement, sex, and method of presentation. Essentially the same contrasts in each of the two multivariate analyses of variance and in the univariate analyses of variance were of prime interest in the study of Wiviott (1970).

The multivariate and univariate analyses of variance were performed using a multivariate (Finn, 1968) computer program with a Type I error rate established at .05 for each test of hypothesis. Univariate $\underline{F}$ tests for the contrast items were fixed at .025 as a means of controlling the error rate of tests considered jointly. This alpha level is determined by taking α/k where k is the number of tests being interpreted, a strategy advocated by Miller (1966) for maintaining the overall familywise error rate, which here is .05.

Analyses of Perceptible, Attribute, and Nominal Responses

The multivariate and univariate analyses of the bases of classification used by Ss on Task I are shown in Tables 8 and 9. The main analyses are reported in Table 8, while the analyses of the interactions between likeness and difference scores for the factors of grade level, achievement level, sex, and method of presentation can be found in Table 9.

Summing over Like and Diff subtasks for all factors (treatment, grade, sex, and achievement), there were significant differences in the

Table 8

Multivariate and Univariate Analyses of Variance of Responses on Task I Contrasting the Perceptible, Attribute, and Nominal Categories

Source	Multivariate Analysis df	F	Probability	Contrast	Univariate Analysis df	F	Probability
Classification (C)	2,71	69.68	<.0001*	P-AN	1,72	3.17	<.0792
				A-N	1,72	86.67	<.0001*
Grade (G)	4,142	1.79	<.1347	P-AN	2,72	1.58	<.2125
				A-N	2,72	2.69	<.0746
Sex (S)	2,71	.18	<.8364	P-AN	1,72	.05	<.8261
				A-N	1,72	.36	<.5528
Achievement (A)/G+S	12,142	.7545	<.6959	P-AN	6,72	.70	<.6483
				A-N	6,72	1.14	<.3498
Treatment (T)	2,71	2.61	<.0803	P-AN	1,72	3.27	<.0748
				A-N	1,72	.11	<.7371
S x G	4,142	.58	<.6784	P-AN	2,72	.25	<.7818
				A-N	2,72	.59	<.5572
T x G	4,142	.74	<.5681	P-AN	2,72	.41	<.6632
				A-N	2,72	.39	<.6799

* Significant at the indicated level.

Table 8 (continued)

Source	Multivariate Analysis df	F	Probability	Contrast	Univariate Analysis df	F	Probability
T x S	2,71	2.95	<.0586	P-AN	1,72	.80	<.3728
				A-N	1,72	2.34	<.1304
G x S x T	4,142	1.26	<.2882	P-AN	2,72	.29	<.7525
				A-N	2,72	1.76	<.1787
T x A/G + S	12,142	.58	<.8562	P-AN	6,72	.39	<.8811
				A-N	6,72	.71	<.6452

Table 9

Multivariate and Univariate Analyses of Variance of Responses on Task I Contrasting the Use of Perceptible, Attribute, and Nominal Categories on Likeness and Difference Subtasks

Source	Multivariate Analysis df	F	Probability	Contrast	Univariate Analysis df	F	Probability
Classification	2,71	28.13	<.0001*	Inter 1[a]	1,72	53.52	<.0001*
				Inter 2[b]	1,72	12.80	<.0007*
Grade (G)	4,142	.04	<.9970	Inter 1	2,72	.04	<.9570
				Inter 2	2,72	.05	<.9482
Sex (S)	2,71	.12	<.8880	Inter 1	1,72	.18	<.6696
				Inter 2	1,72	.11	<.7376
Achievement (A/G+S)	12,142	.61	<.8297	Inter 1	6,72	.77	<.5927
				Inter 2	6,72	.74	<.6167
Treatment (T)	2,71	8.36	<.0006*	Inter 1	1,72	2.57	<.1134
				Inter 2	1,72	16.54	<.0002*
S x G	4,142	.57	<.6825	Inter 1	2,72	.23	<.7936
				Inter 2	2,72	.79	<.4570
T x G	4,142	.80	<.5261	Inter 1	2,72	1.22	<.3010
				Inter 2	2,72	.38	<.6875

* Significant at the indicated level.

a Inter 1 - P Diff, A Like, N Like - P Like, A Diff, N Diff.

b Inter 2 - A Diff, N Like - A Like, N Diff.

Table 9 (continued)

Source	Multivariate Analysis df	F	Probability	Contrast	Univariate Analysis df	F	Probability
T x S	2,71	.63	<.5340	Inter 1	1,72	.11	<.7400
				Inter 2	1,72	1.28	<.2617
G x S x T	4,142	1.25	<.2945	Inter 1	2,72	1.15	<.3218
				Inter 2	2,72	1.67	<.1950
T x A/G + S	12,142	.34	<.9806	Inter 1	6,72	.58	<.7475
				Inter 2	6,72	.15	<.9881

kinds of responses elicited ($p < .0001$). The mean number of Attribute responses (5.36) given by Ss was significantly higher than Perceptible responses (4.12) which was in turn higher than Nominal responses (1.62). In combining the two higher-order categories (A + N), it was also found that Ss in this study use more higher-order responses than lower-order (P) responses.

In examining Like and Diff subtasks, significant results were also obtained for Inter 1 and Inter 2 ($p < .0001$). Ss in this study showed a different profile when asked questions dealing with likenesses than when asked questions dealing with differences. Relatively more Attribute responses (3.34) as compared to Perceptible responses (1.22) were given when questions of likeness were asked than when questions of differences were asked (2.91 and 2.09 for A and P, respectively). The mean number of Nominal responses was relatively the same whether Ss were questioned about likenesses (.86) or differences (.76).

Comparing higher-order versus lower-order responses, it was discovered that relatively more higher-order responses (A + N) were given on the Like subtask than on the Diff subtask. Therefore, it seems reasonable to conclude that questions involving differences between stimuli were much harder to answer than questions involving likenesses between stimuli for subjects in this study.

Contrary to expectation, grade level did not prove to have a significant effect on the kinds of responses. The multivariate F test for the simple main effect of achievement within grade and sex was also non-significant. Little differentiation occurred in the bases of classification as a function of either grade or achievement level-within each grade level and sex group. Sex, as hypothesized, was not a significant factor in performance on the first task. The bases of classification used by males and females were quite similar.

The multivariate $\underline{F}$ test for the method of presentation revealed a marginally significant effect ($\underline{p}$ <.08) in the first multivariate analysis. Univariate $\underline{F}$ statistics were computed for the two orthogonal contrasts and only the univariate $\underline{F}$ for the $P - \overline{A + N}$ contrast was marginally significant ($\underline{p}$ < .07). Treatment had a significant effect on the contrasts in the second multivariate analysis ($\underline{p}$ <.0006); univariate $\underline{F}$ tests were significant for Inter 2 ($\underline{p}$ <.0002), but not significant for Inter 1. Figure 1 shows the mean number of "Diff" and "Like" responses in each of the three categories for pictorial and verbal methods of presentation.

Difficulty is encountered when trying to account for the dissimilarity among the pictorial and verbal treatment groups. Whereas the pictorial group rendered more Attribute Likeness responses than the verbal group, the majority of Attribute Difference responses clearly came from the verbal group. Nominal responses must also be interpreted according to "Like" and "Diff" components because of shifting differences. More Nominal Likeness responses stemmed from the verbal group, but the verbal group was surpassed by the pictorial group in the number of Nominal Difference responses.

Paradoxical as it may seem, one conclusion remains unequivocal. The pictorial method of presentation in Task I did not serve as an

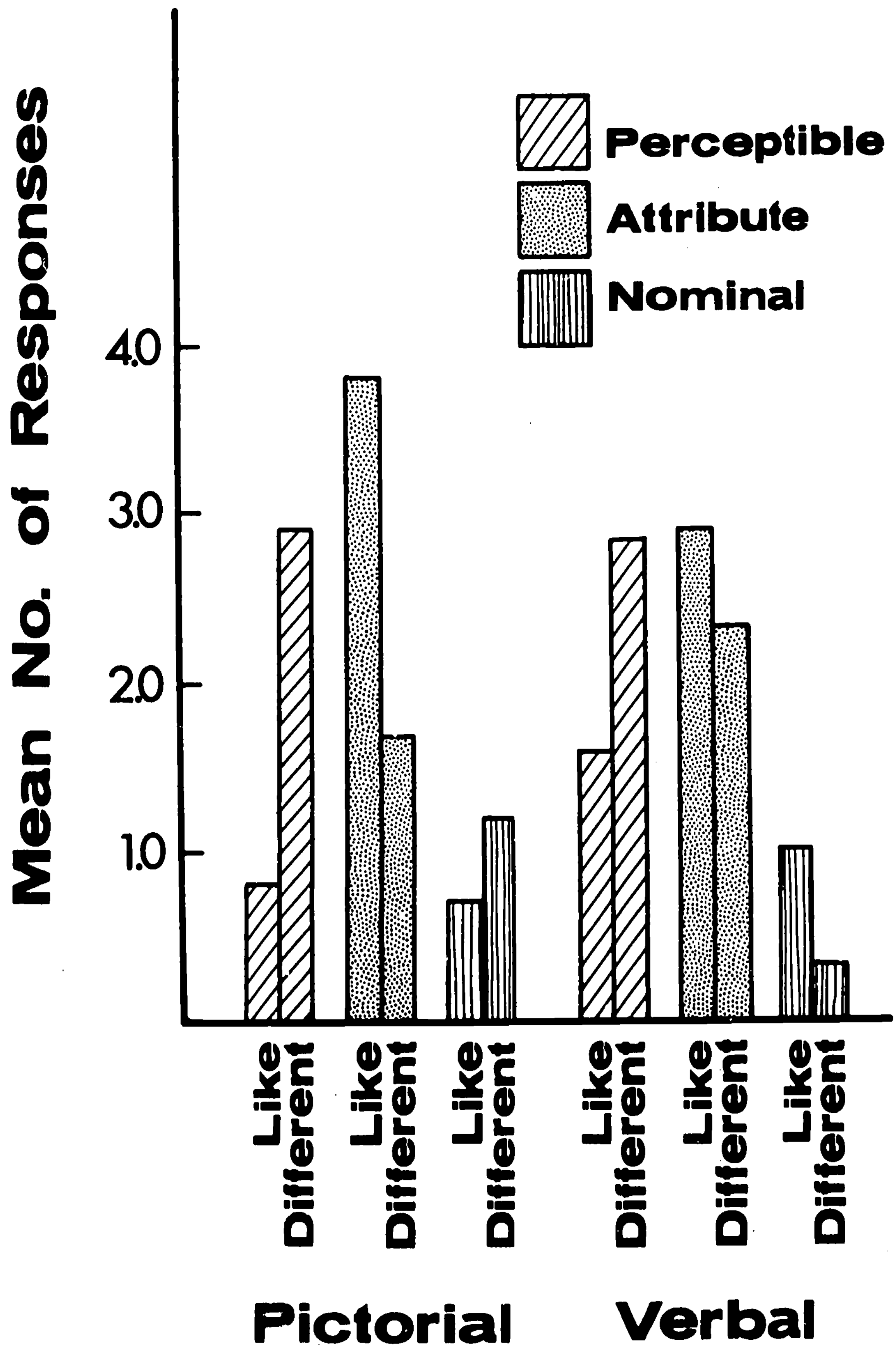

Figure 1. Mean number of responses in Perceptible, Attribute, and Nominal categories used by students in pictorial and verbal treatment groups on Task I.

effective stimulus for provoking significantly more perceptible responses. The pictorial condition seemed to give the best treatment in that relatively more Attribute and Nominal responses were given and relatively few perceptible responses were given as compared to the verbal condition. These findings were in the opposite direction for the study of Wiviott (1970).

A marginally significant finding in the first multivariate analysis of variance (Table 8) was the two-way interaction between sex and treatment ($p < .06$). However, the separate F tests for the two contrasts did not approach significance. Table 10 shows the mean number of responses in each category for the four possible sex x treatment combinations in Task I. Looking at this table, one can observe that the female pictorial and male verbal groups accrued more nominal responses than the corresponding male pictorial and female verbal groups. The mean number of perceptible and attribute responses for these four groups was relatively equal.

Analysis of Subject-Fiat Responses

Subject-Fiat responses were analyzed separately from the other responses and the results are reported here. This category was used to designate Ss' responses which could not fit in one of the other three categories. In practice, this meant some Ss were unable to explain the differences or likenesses among the stimulus objects, and they would customarily respond with the words "I don't know." This kind of response would imply that the question was difficult to answer.

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Table 10

Mean Number of Responses in the Perceptible, Attribute, and Nominal Categories Used by Students in Sex x Treatment Groups on Task I

	P	A	N
Male Pictorial	1.99	2.94	.71
Female Pictorial	1.82	2.63	1.25
Male Verbal	2.11	2.55	.79
Female Verbal	2.40	2.63	.50

Table 11

Univariate Analysis of Variance of Responses on Task I in the Subject-Fiat Category Contrasting Likeness and Difference Subtasks

Source	df	F	Probability
Grade (G)	2,72	.30	< .7453
Sex (S)	1,72	.09	< .7706
Achievement (A/G+S)	6,72	.60	< .7294
Treatment (T)	1,72	5.95	< .0172*
S x G	2,72	.20	< .8192
T x G	2,72	.92	< .4017
T x S	1,72	.77	< .3827
G x S x T	2,72	1.40	< .2533
T x A /G+S	6,72	1.25	< .2927

*Significant at the indicated level.

Table 11 gives the univariate analysis of Subject-Fiat responses on Task I, contrasting likeness and difference subtasks. As may be noted, method of presentation had a significant effect ($p < .02$) on the relative number of Subject-Fiat responses on the likeness and difference subtasks. The means on S Like and S Diff for each treatment group are graphed in Figure 2. Subjects in the pictorial group found the Diff subtask notably easier than the Like subtask, while the verbal group found the two subtasks equally difficult. The total number of Subject-Fiat responses given by the verbal group was greater than that given by the pictorial group. This result was expected since the absence of a picture increases the level of difficulty.

Number of Correct Classifications

Lastly, a univariate analysis was performed on the total number of correct responses for Task I. The mean number of correct classificationsis shown in Table 12 for each of the experimental groups. The results of the analysis of variance are presented in Table 13. While the number of correct responses was found to increase from Grades 5 to 8, and decrease again from Grades 8 to 11, the main effect of grade was only marginally significant ($p < .08$). Each grade level scored relatively high on the total number of correct classifications, however, so differentiation between grades was minimized.

Significant results were also noted for the grade x treatment interaction ($p < .0006$) and in the sex x treatment interaction ($p < .05$). The pictorial group made fewer correct classifications moving from Grade 5 to 11 (11.25 in Grade 5, 11.23 in Grade 8, and 10.44 in Grade 11). On the other hand, the verbal group made more correct classifications moving from Grade 5 (9.81) to Grades 8

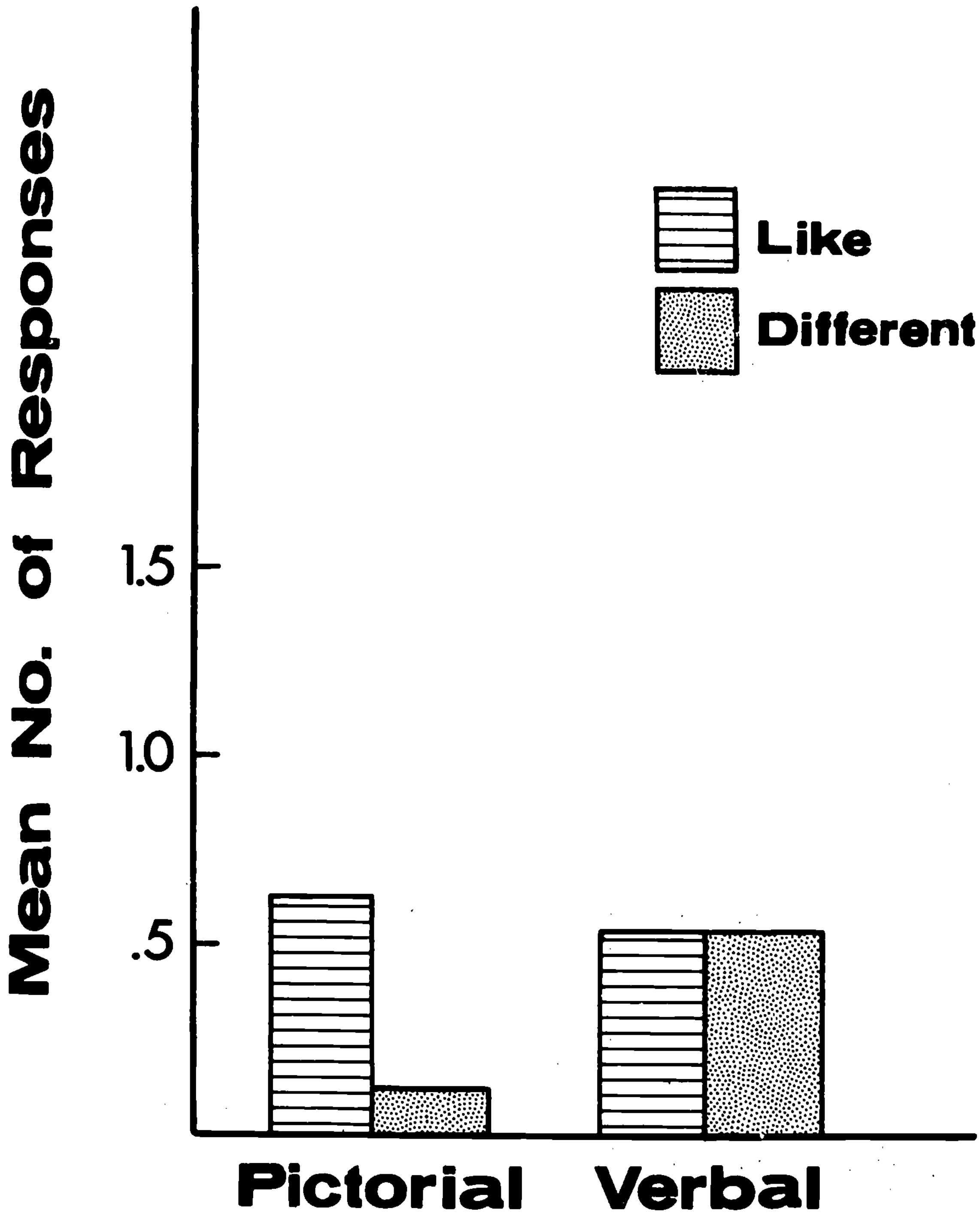

Figure 2. Mean number of responses in the Subject-Fiat category used by students in pictorial and verbal treatment groups on Task I.

Table 12

Means and Standard Deviations of the Total Number of Correct Responses on Task I

Grade	Achievement	Sex	Pictorial	Verbal
5	High	Male	11.75 (.50)	10.0 (.82)
		Female	11.25 (1.50)	10.25 (1.71)
	Low	Male	11.0 (.82)	9.75 (1.50)
		Female	11.0 (1.15)	9.25 (.96)
Fifth Grade Mean			10.53	
8	High	Male	11.50 (.58)	10.50 (1.29)
		Female	12.0 (0)	11.25 (.50)
	Low	Male	11.0 (.82)	11.75 (.50)
		Female	10.0 (.82)	11.50 (.58)
Eighth Grade Mean			11.19	

Table 12 (continued)

Grade	Achievement	Sex	Pictorial	Verbal
11	High	Male	11.25 (.50)	11.0 (1.41)
		Female	10.25 (2.22)	11.50 (.58)
	Low	Male	11.25 (1.50)	11.0 (.82)
		Female	9.0 (2.16)	11.50 (.58)
	Eleventh Grade Mean		10.84	

Note. - Standard deviations are given in parentheses.

Table 13

Univariate Analysis of Variance for Total Number of Correct Responses on Task I

Source	df	F	Probability
Grade (G)	2,72	2.68	< .0752
Sex (S)	1,72	1.17	<.2836
Achievement (A/G+S)	6,72	1.01	<.5000
Treatment (T)	1,72	.52	< .4737
S x G	2,72	.51	< .6022
T x G	2,72	8.28	< .0006*
T x S	1,72	3.92	< .0515*
G x S x T	2,72	1.76	< .1795
T x A/G+S	6,72	1.36	< .2500

*Significant at the indicated level.

and 11 (11.25). Thus, the younger students performed more accurately than the older students when presented with pictures, but the older students performed more accurately when presented with words.

In the sex x treatment combination, males made more correct classifications than females under the pictorial method (11.29 vs. 10.58), but less correct classifications under the verbal method (10.67 vs. 10.88). This female superiority with a verbal presentation is not surprising. The literature (Anastasi, 1958) generally concedes female pre-eminence on verbal functioning tasks throughout the elementary and high school levels.

Task II

Task II required the free sorting of cards from a 26-picture array of various geometric configurations. Subjects were asked to make seven different sorts and to explain the basis of their groupings. Responses were subsequently categorized as Perceptible, Attribute, or Nominal; the Subject-Fiat category was found unnecessary and was, therefore, not utilized for this task. Again, an inter-rater reliability check was performed on a random sample of twenty-four protocols. The percentage of agreement between the two independent ratings was 89.9% for the response data on Task II. The mean number of responses in each category as a function of grade level, achievement level, sex, and method of presentation is shown in Table 14. The number of responses in each category for individual Ss can be found in Appendix B.

Table 14

Means and Standard Deviations of the Number of Responses in Perceptible, Attribute, and Nominal Categories as a Function of Grade, Achievement Level, Sex, and Method of Presentation for Task II

Grade	Group	Pictorial			Verbal		
		P	A	N	P	A	N
5	High Male	3.75 (1.92)	1.0 (1.0)	2.25 (1.09)	2.50 (1.12)	1.0 (1.22)	3.50 (2.29)
	High Female	3.25 (1.64)	1.75 (1.48)	2.0 (1.22)	3.25 (1.09)	2.25 (1.30)	1.50 (.87)
	Low Male	2.50 (.87)	2.75 (1.64)	1.75 (1.79)	2.50 (1.50)	2.0 (1.87)	2.50 (2.06)
	Low Female	3.0 (1.22)	2.75 (1.30)	1.25 (.43)	3.75 (1.92)	1.50 (2.06)	1.75 (1.30)
Fifth Grade Mean		P=3.06	A= 1.88	N= 2.06			
8	High Male	2.0 (.71)	3.0 (2.55)	2.0 (2.0)	1.75 (1.30)	1.50 (1.12)	3.75 (1.09)
	High Female	2.0 (1.22)	3.25 (1.30)	1.75 (1.30)	3.0 (1.0)	2.50 (1.50)	1.50 (1.12)
	Low Male	2.75 (1.09)	1.0 (1.22)	3.25 (1.48)	3.25 (2.28)	2.75 (2.38)	1.0 (.71)
	Low Female	3.0 (.71)	.50 (.87)	3.50 (1.12)	1.75 (.83)	2.75 (1.30)	2.50 (1.50)
Eighth Grade Mean		P = 2.44	A = 2.16	N = 2.41			

Table 14 (continued)

Grade	Group	Pictorial			Verbal		
		P	A	N	P	A	N
11	High Male	2.25 (.43)	3.0 (1.22)	1.75 (1.30)	3.25 (2.49)	1.0 (1.0)	2.75 (1.64)
	High Female	3.75 (.83)	.50 (.50)	2.75 (1.30)	1.75 (1.09)	.75 (.83)	4.50 (1.50)
	Low Male	3.50 (1.50)	2.0 (.71)	1.50 (1.12)	.75 (1.30)	1.75 (1.92)	4.50 (1.66)
	Low Female	1.75 (.83)	1.50 (2.06)	3.75 (1.79)	4.25 (1.92)	.75 (.83)	2.0 (1.22)

Eleventh Grade Mean P= 2.66 A = 1.41 N = 2.94

Note.- Standard deviations are given in parentheses.

Analyses of Perceptible, Attribute, and Nominal Responses

Two orthogonal contrasts consisting of linear combinations of the three categories served as the dependent variables in the multivariate analysis of variance. Again, as in Task I, the first dependent variable was the contrast between the lower-order category and the two higher order categories ($P - \overline{A + N}$). This variable was formed by taking the average number of Attribute and Nominal responses and subtracting it from the number of Perceptible responses. The second dependent variable was the contrast between the higher-order categories (A - N). The effects of the independent variables of grade, achievement, sex, and method of presentation on these contrasts were tested. Method of presentation was retained as a variable in this task analysis since Task II immediately followed Task I and the role of transfer effects was of interest.

Table 15 contains the multivariate and univariate analyses of variance for Task II. Contrary to expectation, grade level was again found not to be significant. Level of achievement was also found not to have a significant effect on the kinds of responses rendered. The bases of classification used by the two achievement groups was remarkably similar with only exiguous differentiation. Sex, as hypothesized, again did not prove to be a significant factor. The differences in the responses of Ss in the pictorial and verbal treatment groups were also non-significant.

Lastly, the multivariate F test for the three-way interaction of treatment, achievement within grade and sex, and classification was

Table 15

Multivariate and Univariate Analyses of Variance of Responses on Task II Contrasting the Perceptible, Attribute, and Nominal Categories

Source	Multivariate Analysis df	F	Probability	Contrast	Univariate Analysis df	F	Probability
Grade (G)	4,142	1.67	<.1602	P-AN	2,72	1.26	<.2886
				A-N	2,72	2.10	<.1296
Sex (S)	2,71	.45	<.6369	P-AN	1,72	.92	<.3405
				A-N	1,72	.00	<.9726
Achievement (A/G+S)	12,142	.80	<.6472	P-AN	6,72	.56	<.7601
				A-N	6,72	1.07	<.3901
Treatment(T)	2,71	.54	<.5839	P-AN	1,72	.20	<.6557
				A-N	1,72	.87	<.3548
S x G	4,142	1.13	<.3461	P-AN	2,72	.23	<.7926
				A-N	2,72	2.08	<.1326
T x G	4,142	.81	<.5178	P-AN	2,72	.08	<.9253
				A-N	2,72	1.57	<.2157
T x S	2,71	1.39	<.2548	P-AN	1,72	.92	<.3405
				A-N	1,72	1.81	<.1828
G x S x T	4,142	.36	<.8348	P-AN	2,72	.45	<.6368
				A-N	2,72	.27	<.7659
T x A/G+S	12,142	2.11	<.0198*	P-AN	6,72	2.75	<.0182 *
				A-N	6,72	1.53	<.1795

*Significant at the indicated level.

significant ($p < .02$). Looking at the univariate tests for the contrasts which served as dependent variables in the multivariate analysis, it is noted that the univariate F test for the classification contrast, P-AN, was significant ($p < .02$) while the A-N contrast was not. Within the P-AN contrast, there were significant effects in the eleventh grade for males and females. However, turning attention to Figures 3a-d which graph these interactions, the effect was found to be opposite for males and females. The significant interaction remains difficult to interpret.

Number of Correct Classifications

A univariate analysis of variance on total number of correct responses was also carried out for Task II. The mean number of correct responses are shown in Table 16 for each experimental group. The results of the analysis of variance are given in Table 17. Again as in Task I, the number of correct responses increased from Grades 5 to 8 and decreased from Grades 8 to 11. The effect of grade level was marginally significant ($p < .06$). All three grade levels exhibited relatively high scores in accurate classifications on Task II.

Comparative Results for High vs. Low SES Subjects

The present study was designed as a direct replication of the study of Wiviott (1970). The same tasks were administered to Ss in both studies, with the only major differences between the studies being the socioeconomic background of the Ss and the treatment of the

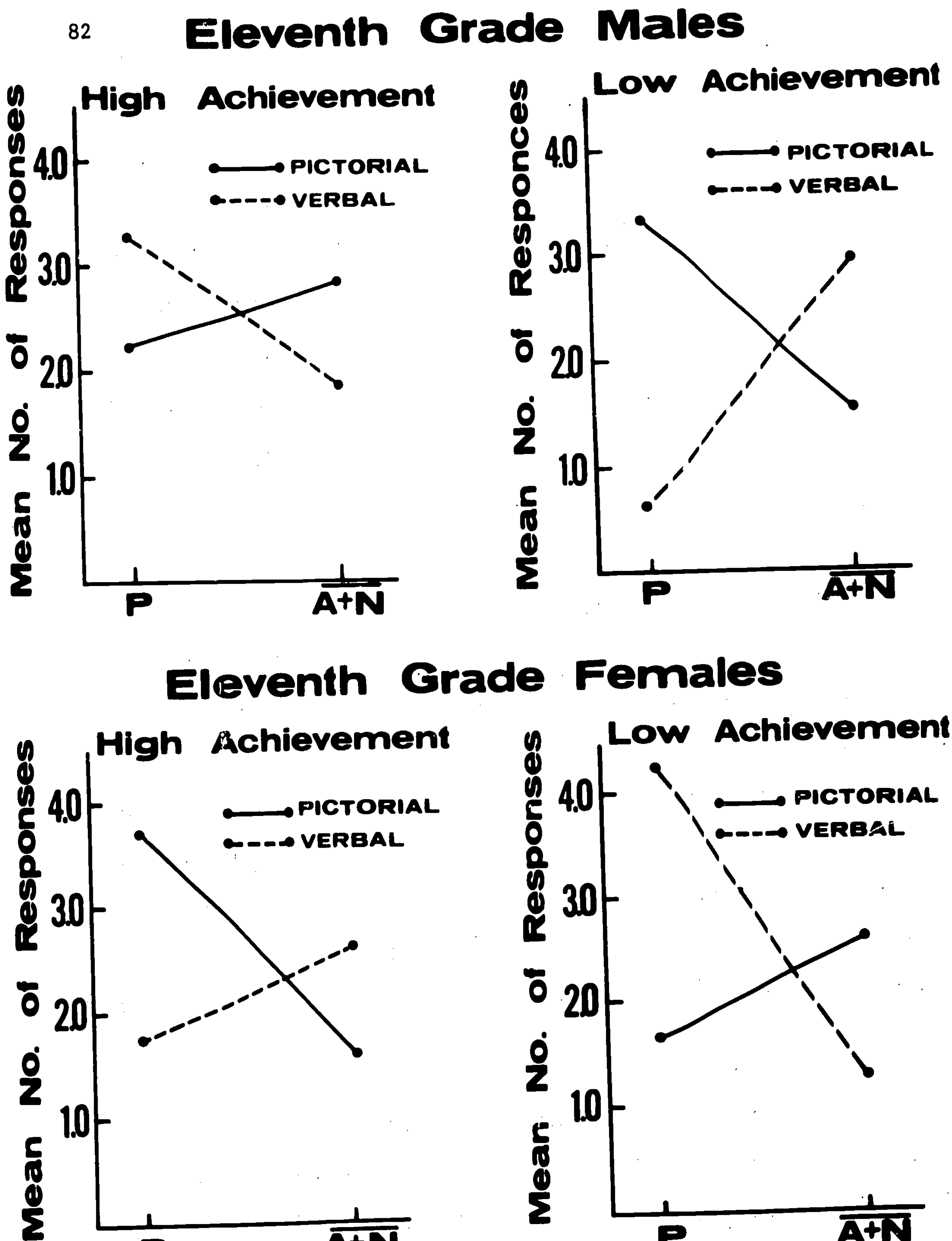

Figure 3a-d. Mean number of classifications given for lower-order (P) and higher-order $(\overline{A + N})$ categories by eleventh grade Ss as a function of sex, achievement, and treatment.

Table 16

Means and Standard Deviations of the Total Number of Correct Responses on Task II

Grade	Achievement	Sex	Pictorial	Verbal
5	High	Male	6.25 (.50)	6.50 (.58)
		Female	6.0 (1.15)	6.75 (.50)
	Low	Male	6.25 (.50)	6.50 (.58)
		Female	6.75 (.50)	6.75 (.50)
	Fifth Grade Mean		6.47	
8	High	Male	7.0 (0)	6.75 (.50)
		Female	6.75 (.50)	6.75 (.50)
	Low	Male	6.25 (.96)	6.50 (1.0)
		Female	6.25 (.96)	6.0 (.82)
	Eighth Grade Mean		6.53	

Table 16 (continued)

Grade	Achievement	Sex	Pictorial	Verbal
11	High	Male	6.50 (.58)	6.50 (.58)
		Female	6.50 (.58)	5.75 (.96)
	Low	Male	6.75 (.50)	5.50 (1.0)
		Female	5.0 (1.83)	6.25 (.96)
	Eleventh Grade Mean		6.09	

Note.-Standard deviations are given in parentheses.

Table 17

Univariate Analysis of Variance for Total Number of Correct Responses on Task II

Source	df	F	Probability
Grade (G)	2,72	2.88	<.0625
Sex (S)	1,72	.82	<.3679
Achievement (A/G+S)	6,72	1.26	<.5000
Treatment (T)	1,72	.02	<.8974
S x G	2,72	1.27	<.2861
T x G	2,72	.87	<.4227
T x S	1,72	.82	<.3679
G x S x T	2,72	.87	<.4227
T x A/G+S	6,72	1.73	<.2500

blocking factor in the analyses. Wiviott used high SES students for her study and blocked on achievement within grade. The present study was carried out with low SES students and blocked on achievement within grade and sex. Because of the blocking differences, comparisons between the two studies based upon achievement are difficult to make.

Grade level had a significant effect on bases of classification in Wiviott's study. A decrease in the use of the Perceptible basis of classification and an increase in the use of the Attribute and Nominal bases occurred concomitantly with an increase in grade level. Figures 4-10 juxtapose the results for each response category on Tasks I and II for Wiviott's study and the present study. Two features are most salient in these graphs. First, fifth and eighth graders in both studies make the same directional changes between grades in their use of Perceptible, Attribute, and Nominal responses. That is, both studies show a decline in the mean number of Perceptible responses, and an increase in the mean number of Attribute (for Task I only) and Nominal responses. Furthermore, directional changes in the use of Nominal responses are the same across all three grade levels for both studies. Eleventh graders, therefore, can be seen as the source of dissonance between the two studies. In the present study, the mean number of Perceptible and Attribute responses at the eleventh grade level clashes with the developmental trend established in the fifth and eighth grades.

The second striking feature found in Figures 4-10 is the level of absolute performance of Ss in each study. Ss participating in the present study showed a greater mean number of Perceptible responses than Ss in the Wiviott study in grades 5, 8, and 11. In addition,

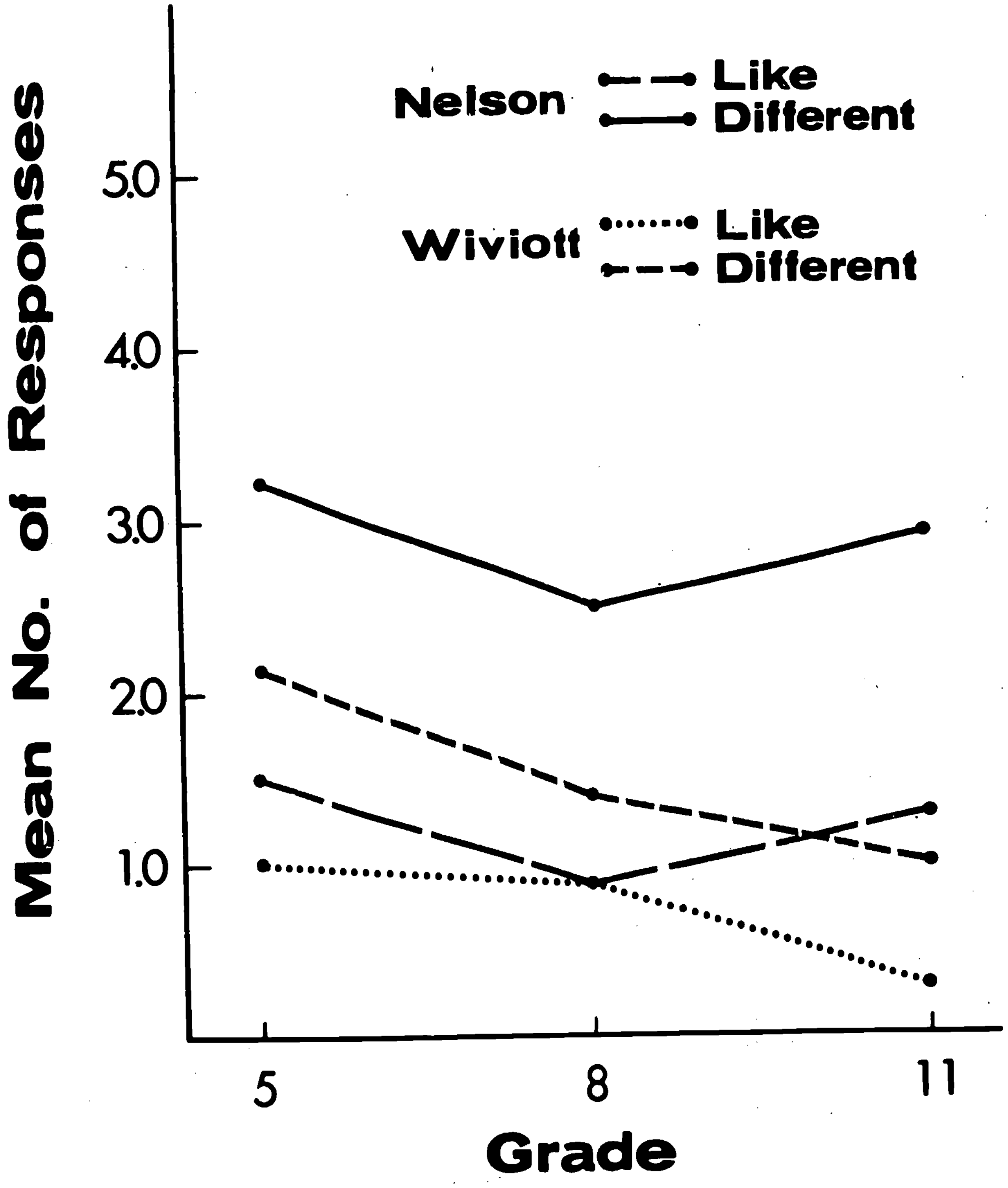

Figure 4. Mean number of Like and Diff responses in the Perceptible category used by students in grades 5, 8, and 11 on Task I for the Nelson and Wiviott studies

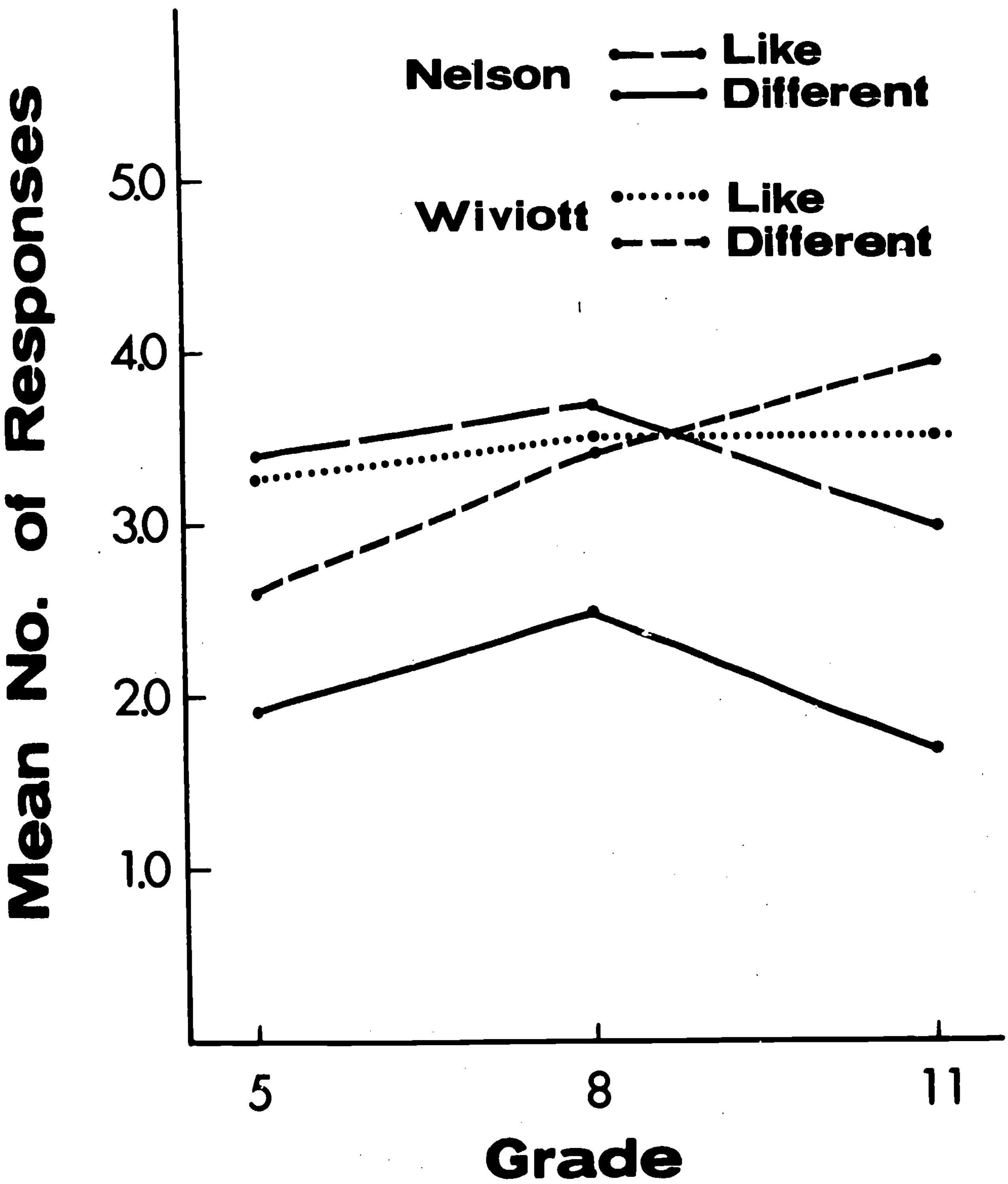

Figure 5. Mean number of Like and Diff responses in the Attribute category used by students in grades 5, 8, and 11 on Task I for the Nelson and Wiviott studies.

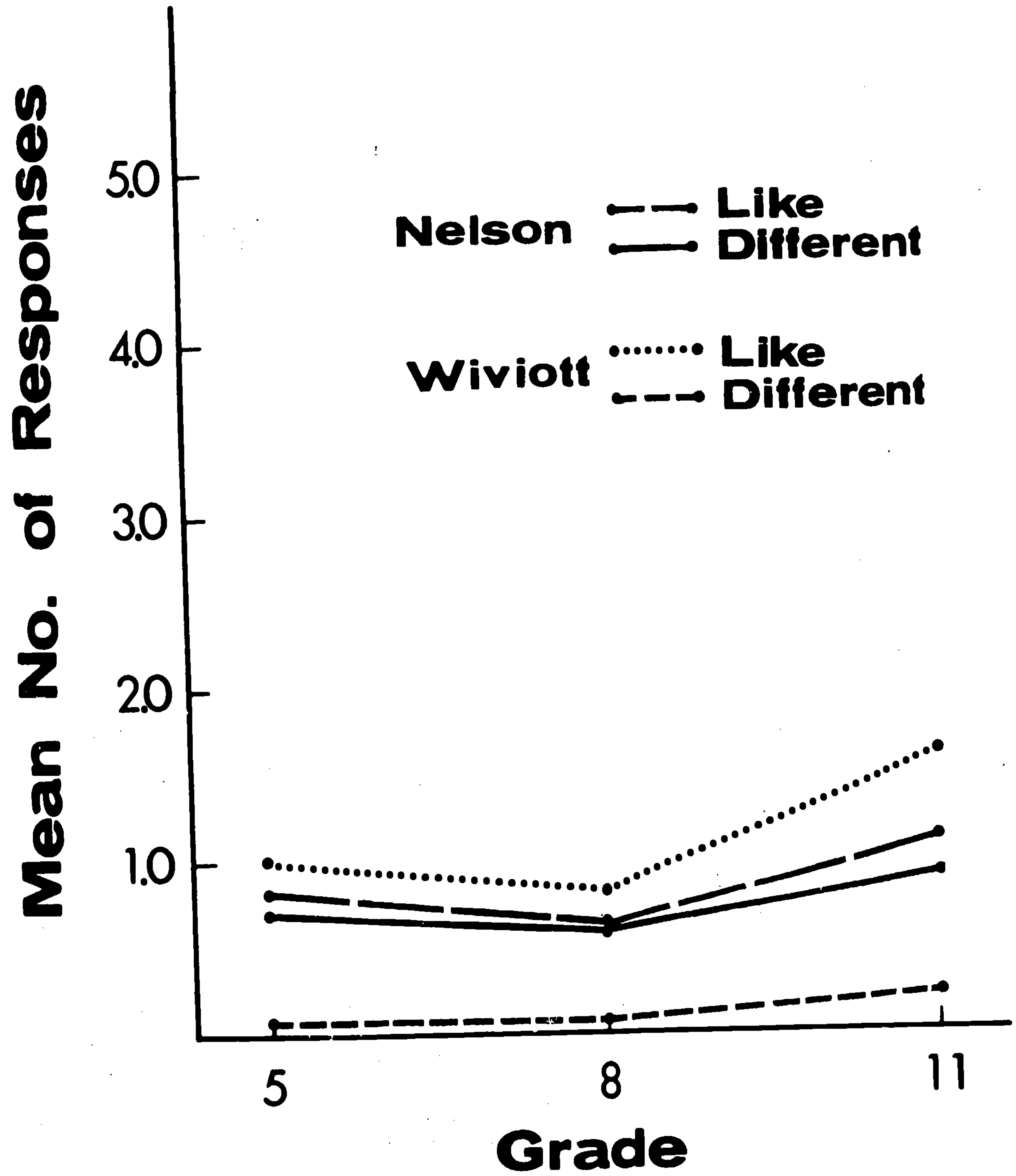

Figure 6. Mean number of Like and Diff responses in the Nominal category used by students in grades 5, 8, and 11 on Task I for the Nelson and Wiviott studies .

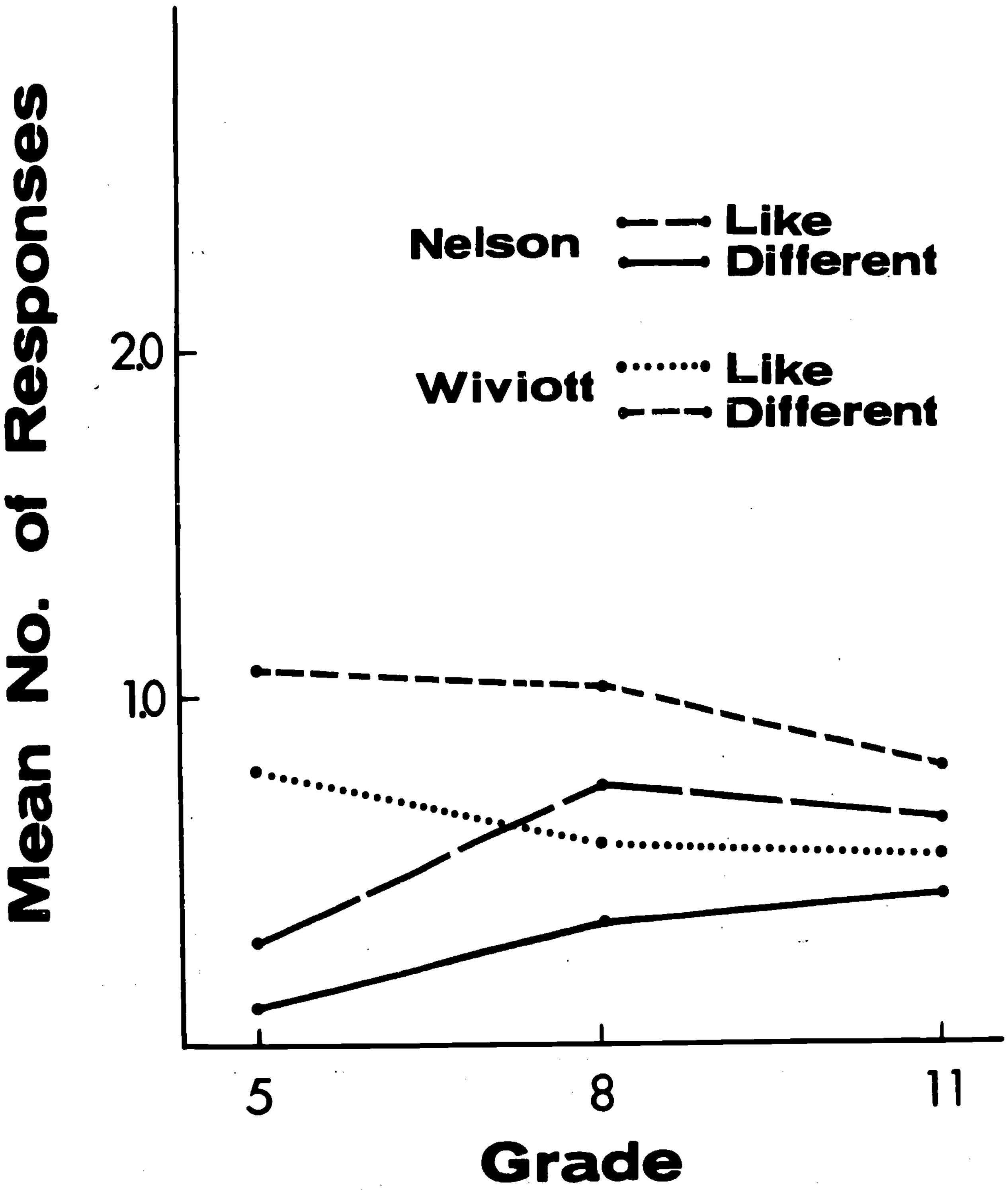

Figure 7. Mean number of Like and Diff responses in the Subject-Fiat category used by students in grades 5, 8, and 11 on Task I for the Nelson and Wiviott studies.

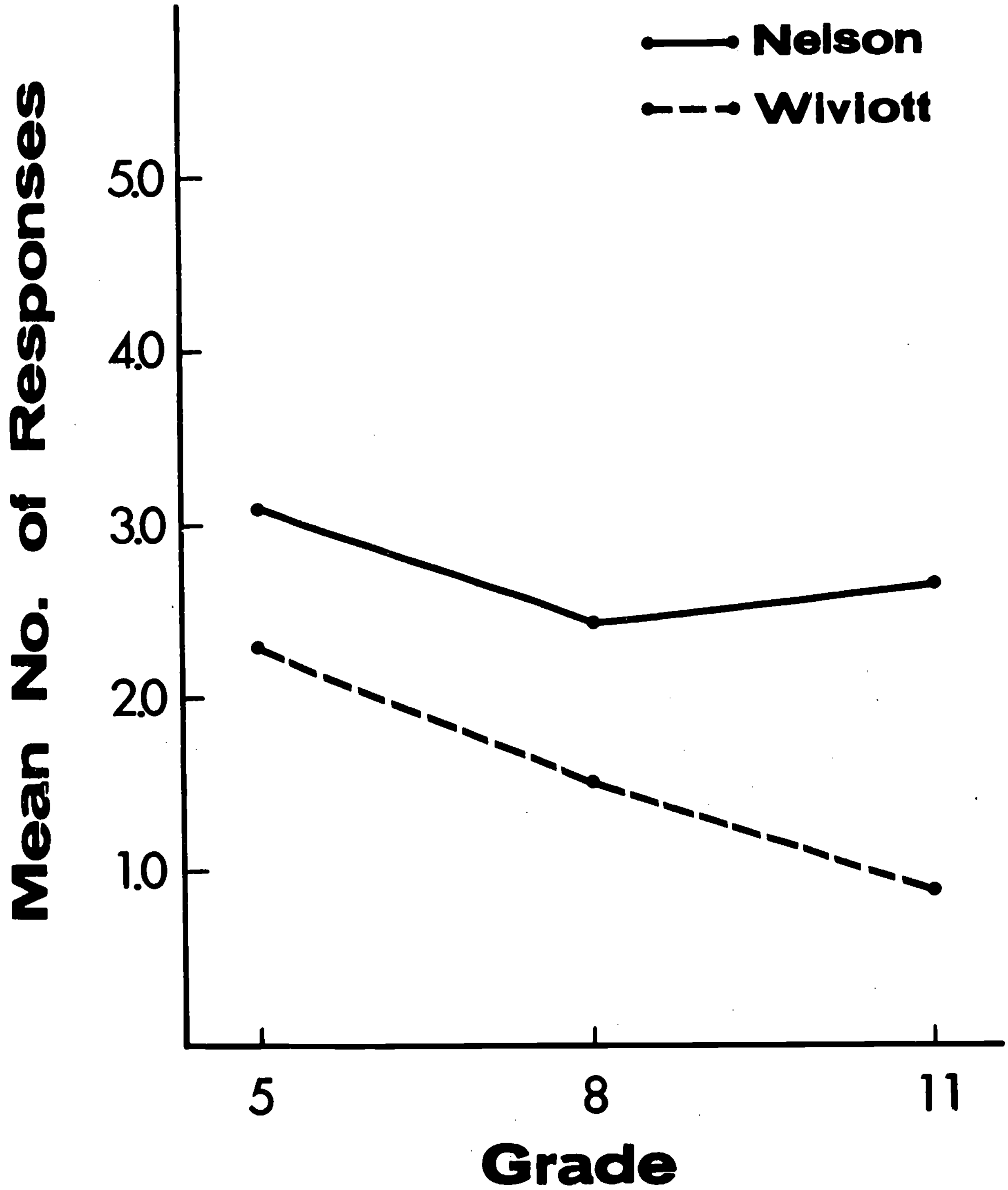

Figure 8. Mean number of Perceptible responses used by students in grades 5, 8, and 11 on Task II for the Nelson and Wiviott studies.

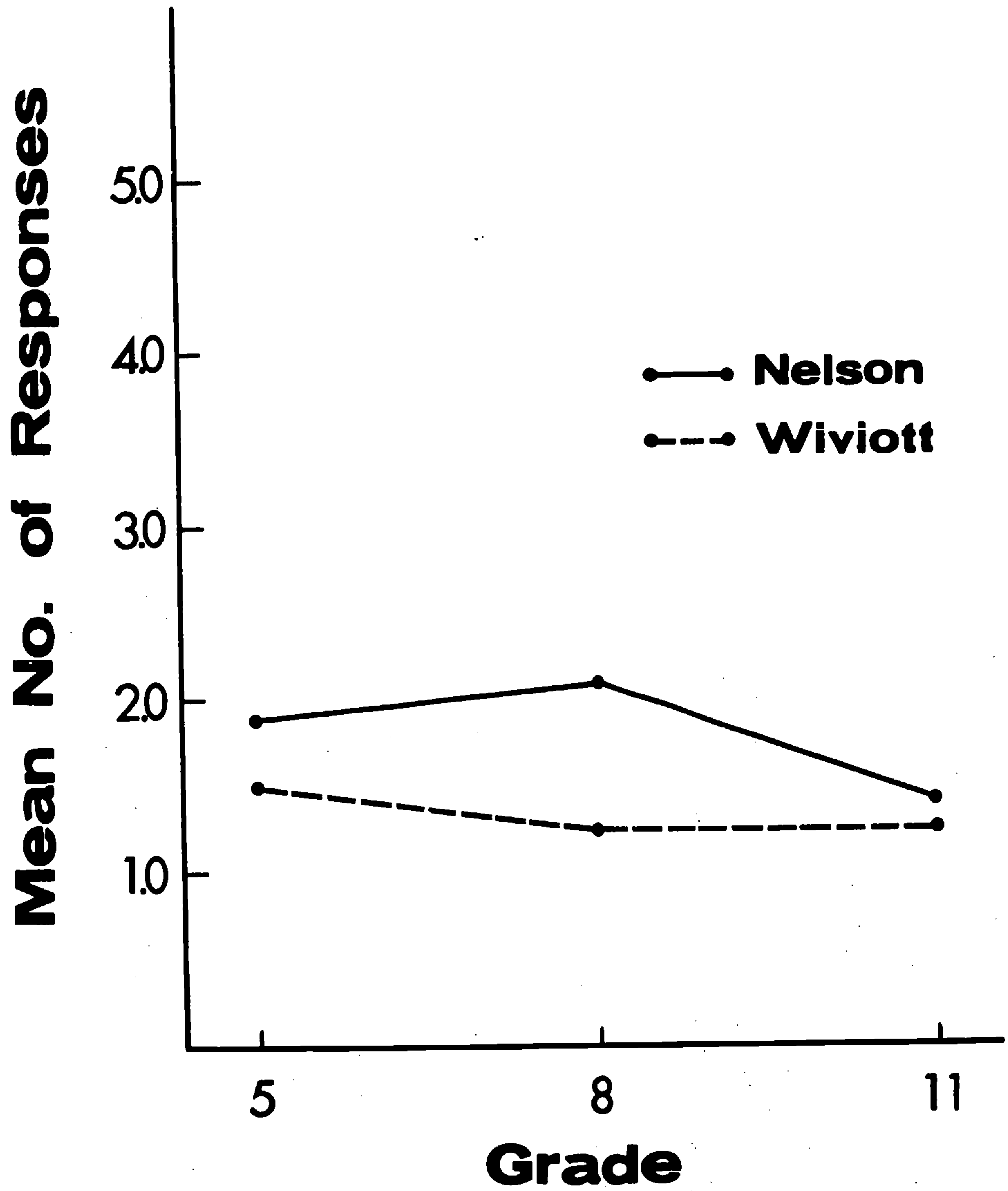

Figure 9. Mean number of Attribute responses used by students in grades 5, 8, and 11 on Task II for the Nelson and Wiviott studies.

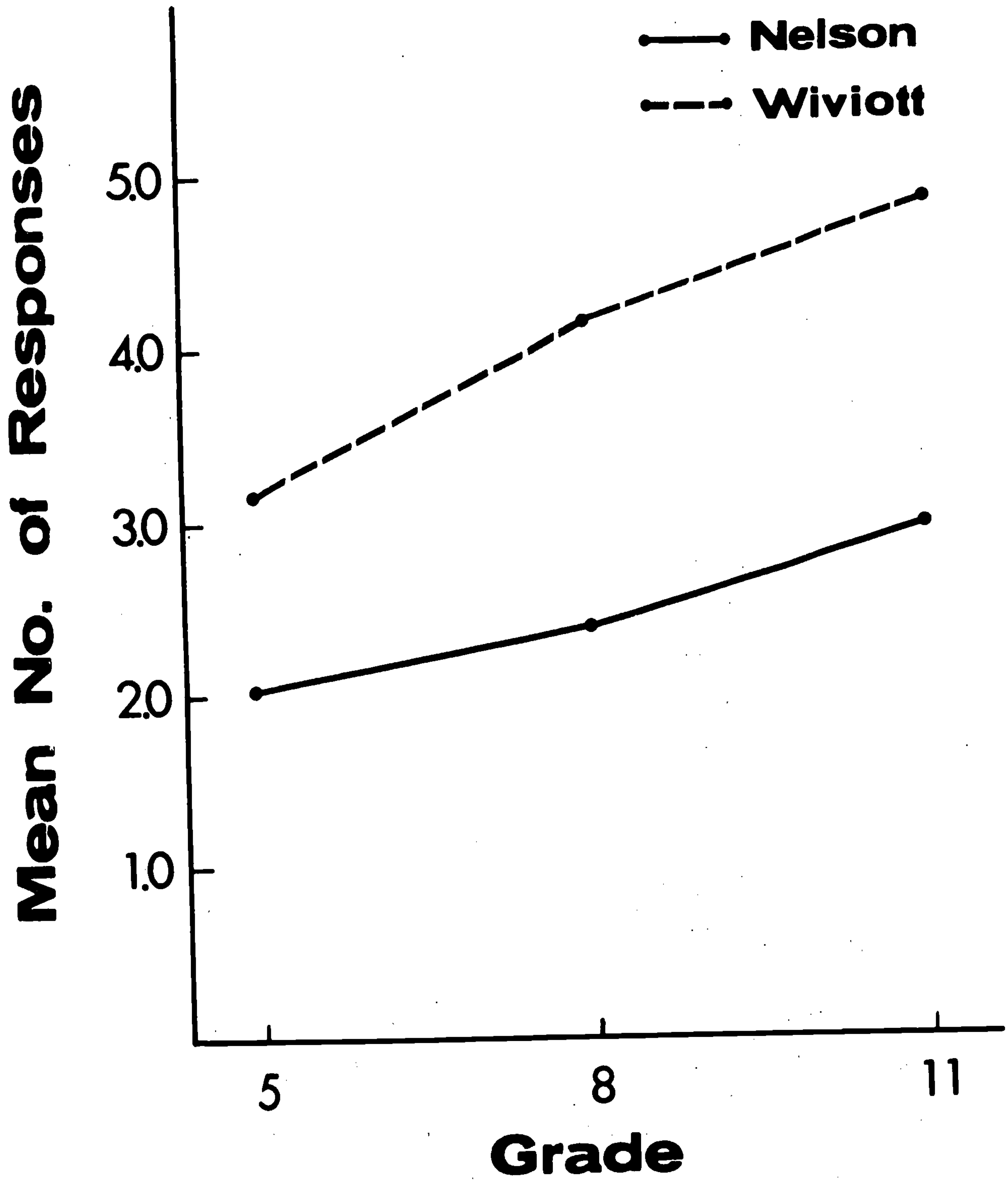

Figure 10. Mean number of Nominal responses used by students in grades 5, 8, and 11 on Task II for the Nelson and Wiviott studies.

Ss in the present study provided fewer Nominal responses than Wiviott's Ss. Major differences between the two studies were greater with respect to the Diff subtask than the Like subtask in Task I. On the basis of these findings, it would seem reasonable to conclude that low SES students tend to make more Perceptible responses and fewer Nominal responses than high SES Ss. Stated another way, low SES students perhaps find the perceptible properties of objects easier to deal with, and the labels for these objects more difficult, than students from a higher SES background. Similar conclusions cannot justifiably be reached for the Attribute category where the number of responses given by high and low SES students were quite similar.

Wiviott's study also found that achievement level had a significant effect on the bases of classification. High achievers used fewer Perceptible and more Attribute and Nominal bases of classification than low achievers. This did not hold true in the present study; high and low achievers responded with the same frequency in each of the three categories. One plausible explanation of why high achievers performed better than low achievers in the one study but not in the other has to do with the absolute achievement levels of high and low achievers in the two studies. In the present study, there was very little differentiation between high and low achievers. Ss assigned to the high achievement group were frequently students scoring on standardized tests at the national mean or just below it for their particular grade level. However, in the Wiviott study high and low achievers were clearly differentiated, with high achievers performing well above the national norm.

Sex differences proved to be negligible on Tasks I and II both in the Wiviott study and in the present one, thereby supporting the hypothesis of no difference. Males and females gave approximately the same numbers of Perceptible, Attribute, Nominal, and Subject-Fiat responses.

For the Wiviott study, method of presentation had a significant effect on the bases of classification. Ss who were presented with pictorial stimuli gave more Perceptible responses than Ss who were presented with verbal stimuli. In the current study, however, this trend operated in the other direction: Ss who were presented with pictorial stimuli gave fewer Perceptible responses than Ss who were presented with verbal stimuli.

Conclusions

The most bewildering outcome of the present study was the absence of developmental change among the three grade levels. It might be recalled that the only expected changes which occurred between grade levels was a decrease in the use of the Perceptible basis of classification and an increase in the use of the Attribute basis of classification for Grades 5 and 8 only. The eleventh grade did not follow the pattern established in the fifth and eighth grades.

In attempting to solve the puzzle of the anomalous eleventh grade performance, one artifact underlying this study was brought to light. There were some Ss participating in the study who had been introduced to fundamental geometric concepts. Each S was asked whether he had experience with geometric concepts, and if so, to explain his level of familiarity. It was found that at the fifth grade level 25% of the Ss had a rudimentary understanding of the geometric concepts employed in this study; 41% had this understanding at the eighth grade level; and none at the eleventh grade level.

Having made this discovery, the data were re-examined in order to see what possible differences existed between Ss who claimed to have some understanding of the concepts and those who did not. It was found that Ss with previous exposure to geometry performed better than Ss who did not have this experience: Perceptible responses were fewer while Attribute and Nominal responses were greater for Ss with a geometry background. However, these findings were not found to be significant in a post hoc analysis of variance with geometry training included as a factor. Disproportionate cell observations and the small number of Ss in the "geometry experience group" can be cited as possible explanations for not obtaining a significant result. School records were also checked to confirm what was reported on questionnaires from Ss in the study. Records concurred in that no eleventh grade subject had geometry training. Curriculum consultants for the school district also stated that the fifth and eighth grade Ss in the present study were affected by an upgrading in the elementary mathematics program, which in recent years has stressed learning of basic geometric concepts. Eleventh grade Ss were not affected by this change in curriculum.

Consideration was also given to the possibility of misjudgments in rating the protocols. The likelihood of error was checked by having Wiviott reanalyze the data independently. Her analysis yielded very similar results with what has already been reported in this chapter.

Again, Perceptible responses decreased from fifth grade to eighth grade and increased at the eleventh grade level; Attribute responses increased from fifth grade to eighth grade but dropped at the eleventh grade. The reanalysis yielded no significant results for the main effects of grade level, achievement level, sex, or method of presentation for Task I or II.

It is conceivable that the overall lack of variability among Ss in this study on classification tasks might be due to their low socioeconomic background. The disparities in performance between high SES Ss in Wiviott's study and low SES Ss in the present study cannot be ignored or regarded lightly. As mentioned above, the disadvantaged students used the Perceptible basis of classification more frequently and the Nominal basis less frequently than high SES Ss (Figures 4, 6, 8, and 10). Although prior investigations have already found considerable differences between socioeconomic groups in classificatory behavior (Findlay & McGuire, 1957; Raven, 1967; Siller, 1957, 1958), it has also been noted that educational experience tends to mitigate these differences (Evans & Segall, 1969; Greenfield, Reich, & Olver, 1966; Schmidt & Nzimande, 1970). If the educational factor is as critical as we are led to believe, at least in terms of years of schooling, then one would expect some kind of developmental change arising among the disadvantaged students. Future investigations are necessary and essential to answer more definitively questions of variability within the lower socioeconomic groups.

Chapter V

SUMMARY AND IMPLICATIONS

Summary

The purpose of this study was to determine the relationship of method of presentation, grade level, sex, and achievement level within grade and sex to the various bases upon which children of low socioeconomic background classify geometric concepts. In addition, results of the experiment were compared with the findings of Wiviott (1970) for high socioeconomic children.

The hypotheses to be tested were as follows:

(i) Low SES children in grades 5, 8, and 11 differ in their bases of classifying geometric figures. In the lower grade levels children depend more upon a Perceptible bases than children in the upper grades. Conversely, children in the upper grades depend more upon Attribute and Nominal bases of classification than children in the lower grades.

(ii) Low SES children of high and low achievement differ in their bases of classifying geometric figures. Low achievers give more Perceptible responses than high achievers, while high achievers give more Attribute and Nominal responses than low achievers.

(iii) Low SES boys and girls do not differ in their bases of classifying geometric figures.

(iv) Verbal and pictorial methods of presentation have a significant effect on the bases of classifying geometric figures among low SES children. A pictorial presentation elicits more Perceptible responses than a verbal presentation.

(v) The total number of correct classifications differs only as a function of achievement level. High achievers give more correct responses than low achievers.

Ninety-six students from a low SES urban population served as Ss for the experiment. They were randomly selected from the fifth, eighth, and eleventh grades, 32 children at each grade level, and stratified according to sex and mathematics achievement level within grade and sex. Ss within each sex by achievement level were randomly assigned to either a verbal or pictorial treatment group. The experimental design was a 2 x 3 x 2 x 2 nested factorial with method of presentation (verbal or pictorial), grade level (5, 8, or 11), sex (male or female), and mathematics achievement level (high or low) within grade and sex as factors.

Two tasks were administered consecutively to each S under individual testing conditions. The first was an equivalence task consisting of eight geometric cards presented in a fixed order. The geometric concepts which comprised the array were: square, rectangle, rhombus, parallelogram, quadrilateral, triangle, circle, and cube. Half the Ss were shown cards with geometric concept instances printed on them, while the other half were shown cards with geometric concept names printed on them. Ss were asked to explain the similarities and differences between concepts; six similarity and six difference judgments were elicited.

The second task was a free-sort entailing 26 geometric concept examples printed on individual cards. The concepts were the same as in the first task (except cube), but examples varied along the irrelevant dimensions of size and orientation. The S was asked to construct groups of pictures by selecting those figures that appeared alike to him in some way and to tell the basis for his grouping. After completing a group, the S was asked to repeat the operation until seven groups had been formed.

Task I responses were classified into Perceptible, Attribute, Nominal, and Subject-Fiat categories; for Task II responses, only Perceptible, Attribute, and Nominal categories were used. Multivariate analyses of variance were performed on linear contrasts of the number of Perceptible, Attribute, and Nominal responses for Tasks I and II. Univariate analyses of variance were also carried out on the difference between the number of Subject-Fiat "Diff" and Subject-Fiat "Like" responses in Task I and for the total number of correct responses in Tasks I and II.

The following conclusions can be drawn from this study:

1. Grade Level -- On both tasks, grade level did not prove to have a significant effect on the bases of classification for disadvantaged Ss in this study. An increase in grade level was not accompanied by a decrease in the use of the Perceptible basis of classification, nor was it accompanied by an increase in the use of Attribute and Nominal bases of classification. Little

variability prevailed among these low SES Ss in their use of lower-order and higher-order bases of classification. Moreover, in terms of absolute performance, the low SES students at any given grade level used more Perceptible responses and fewer Nominal responses than high SES Ss in the study of Wiviott.

2. Achievement Level -- Achievement level did not have a significant effect on bases of classification for either task. High achievers responded very similarly to low achievers in the use of Perceptible, Attribute, and Nominal categories. The most tenable explanation for this outcome is that the level of achievement for Ss in the high achievement group did not differ substantially from that of Ss in the low achievement group.

3. Sex -- As hypothesized, sex did not have a significant effect on bases of classification for Task I or II.

4. Method of Presentation -- The method of presentation proved not to have the predicted effect on bases of classification for either Task I or II. The pictorial presentation did not elicit any greater mean number of Perceptible responses than the verbal presentation. However, some significant differences resulted in Task I according to subtasks. Ss in the pictorial group rendered significantly more Attribute Likeness and Nominal Difference responses, while the verbal group rendered more Attribute Difference and Nominal Likeness responses.

5. Total number of Correct Responses -- The total number of correct responses increased from Grades 5 to 8 and decreased from Grades 8 to 11. This trend was marginally significant in Task I and

Task II. Achievement level did not have a significant effect on the correctness of responses.

Implications

Perhaps the most important implication of this study for education is the need to modify or improve children's classification skills by instruction. Very few attempts have been undertaken to stimulate these changes, but the few that have been carried out have yielded some encouraging results. Butters (1969) found that for first graders practice with verbally presented equivalence tasks resulted in more functional responses than did practice with perceptually or functionally presented items. Edwards (1969) instructed groups of first grade boys in matching objects. The Ss received instructional booklets containing common objects which were classified in different ways, and they received verbal cues describing the basis for matching one object with another. The results of this experiment indicated that children's classification skills can be modified on a group instructional basis in a short length of time. Raven (1970) also observed improvements in classification abilities with second and third grade children through an instructional program which incorporated a deductive-generalization approach.

In the field of biological science, Hungerford (1969) noted that four weeks of training for seventh grade students brought forth improvements in algae classification. However, it was also discovered that when the goal is classification behavior, general skill training is not totally sufficient. Specific training in classification with the subject matter seems to be required for maximum performance.

A major program of research to enhance classification skills in young children recently has been undertaken by Sigel and his co-workers (Olmsted, Parks, & Rickel, 1970; Sigel, 1971). While the preliminary reports suggest that middle class children profit from classification training, lower-class children seem to encounter greater difficulty, particularly in working with representational material.

The literature review in Chapter 2 recaptured highlights of fifty years of research on classificatory behavior, beginning with "color, form, size" experiments and culminating with investigations into the logical operations underlying classificatory behavior. It is apparent that research in this area has moved a long way during this time. Nevertheless, it remains clear that there is an acute need to see this research through to completion.

The Wisconsin Research and Development Center for Cognitive Learning has an active concern for improving educational practices through programmatic research. The nurturing of classification skills or "concept learning," as it is usually called, is of special interest. The approach of the Center has been to conduct research on the cognitive operations involved in concept learning, and to develop instructional theories and educational materials for different subject matter areas based on the research. The Center plans to continue research and development related to classificatory skills in order to meet the varying needs of children.

Appendix A

Instructions to Students

GPO 825-074-9

General

We are doing an educational study in order to see how students like yourself look at certain things. You can be of great help to us by answering a number of questions. You will not receive a grade, and I will be the only person to look at your answers.

Task I: Pictorial Treatment Group

I will show you some white cards with pictures printed on them. As I show the cards, I will ask you either how they are alike or how they are different from each other. Try to give me your best answer for each question.

Task I: Verbal Treatment Group

I will show you some white cards with words printed on them. First, the words will be pronounced for you and you can repeat them after me. As I show the cards, I will ask you either how they are alike or how they are different from each other. Try to give me your best answer for each question.

Task II: Free Sort

I am going to show you a group of pictures. Look at all the pictures that are placed before you. I want you to select from this group some of the pictures--any of them--that are alike to you in some way. Remove these pictures from the main group. Take as few or as many pictures as you like.

Now, tell me how the pictures in your group are alike.

Appendix B

Response Data for Task I and Task II

Task I - Response Data

Treatment Group	S	P Like	A Like	N Like	S Like	P Diff	A Diff	N Diff	S Diff	Total Correct Responses
Grade 5 High Male Pictorial	1	0	4	1	1	4	0	2	0	12
	2	1	5	0	0	5	0	1	0	12
	3	0	1	2	3	3	1	2	0	11
	4	3	3	0	0	5	1	0	0	12
Grade 5 High Male Verbal	5	0	4	2	0	3	1	1	1	10
	6	5	1	0	0	2	4	0	0	10
	7	1	0	5	0	6	0	0	0	9
	8	3	3	0	0	2	3	0	1	11
Grade 5 High Female Pictorial	9	1	5	0	0	3	1	2	0	12
	10	0	5	0	1	3	3	0	0	12
	11	0	1	5	0	4	0	2	0	9
	12	0	5	0	1	3	2	1	0	12
Grade 5 High Female Verbal	13	3	2	1	0	4	1	1	0	11
	14	5	1	0	0	3	3	0	0	8
	15	6	0	0	0	2	4	0	0	10
	16	1	5	0	0	6	0	0	0	12
Grade 5 Low Male Pictorial	17	0	6	0	0	1	3	1	1	11
	18	3	3	0	0	3	2	1	0	11
	19	1	3	2	0	3	2	1	0	10
	20	0	6	0	0	3	3	0	0	12

Treatment Group	S	P Like	A Like	N Like	S Like	P Diff	A Diff	N Diff	S Diff	Total Correct Responses
Grade Low Male Verbal	21	2	3	1	0	2	4	0	0	11
	22	3	1	2	0	1	3	2	0	9
	23	0	4	2	0	5	1	0	0	8
	24	2	3	1	0	2	4	0	0	11
Grade 5 Low Female Pictorial	25	1	3	0	2	3	1	2	0	12
	26	0	3	3	0	3	3	0	0	10
	27	0	4	0	2	2	1	2	1	12
	28	0	6	0	0	5	0	1	0	10
Grade 5 Low Female Verbal	29	4	2	0	0	2	3	1	0	9
	30	1	5	0	0	5	1	0	0	10
	31	0	6	0	0	1	4	1	0	8
	32	1	5	0	0	4	2	0	0	10
Grade 8 High Male Pictorial	33	0	6	0	0	5	1	0	0	12
	34	0	6	0	0	2	2	2	0	11
	35	3	3	0	0	2	4	0	0	11
	36	1	4	0	1	4	2	0	0	12
Grade 8 High Male Verbal	37	2	4	0	0	5	1	0	0	11
	38	0	6	0	0	2	3	1	0	9
	39	0	6	0	0	0	6	0	0	10
	40	2	2	2	0	4	2	0	0	12

Treatment Group	S	P Like	A Like	N Like	S Like	P Diff	A Diff	N Diff	S Diff	Total Correct Responses
Grade 8 High Female Pictorial	41	0	4	0	2	3	3	0	0	12
	42	1	5	0	0	3	3	0	0	12
	43	0	6	0	0	4	1	1	0	12
	44	0	6	0	0	1	4	1	0	12
Grade 8 High Female Verbal	45	1	0	5	0	2	2	1	1	11
	46	0	3	1	2	2	1	0	3	12
	47	4	1	1	0	1	5	0	0	11
	48	0	5	1	0	3	3	0	0	11
Grade 8 Low Male Pictorial	49	4	0	0	2	2	1	3	0	11
	50	0	6	0	0	0	6	0	0	12
	51	2	3	1	0	3	1	2	0	10
	52	0	6	0	0	3	2	1	0	11
Grade 8 Low Male Verbal	53	1	0	0	5	3	3	0	0	12
	54	2	1	0	3	1	2	0	3	12
	55	1	3	2	0	0	4	0	2	11
	56	0	5	0	1	4	1	0	1	12

Treatment Group	S	P Like	A Like	N Like	S Like	P Diff	A Diff	N Diff	S Diff	Total Correct Responses
Grade 8	57	0	3	3	0	5	0	1	0	9
Low	58	3	3	0	0	1	3	2	0	10
Female	59	0	4	0	2	4	2	0	0	11
Pictorial	60	0	5	1	0	1	1	4	0	10
Grade 8	61	2	0	4	0	6	0	0	0	11
Low	62	0	3	0	3	1	3	0	2	11
Female	63	0	6	0	0	2	4	0	0	12
Verbal	64	0	3	0	3	3	3	0	0	12
Grade 11	65	1	3	0	2	4	2	0	0	11
High	66	1	5	0	0	3	3	0	0	11
Male	67	0	5	1	0	4	0	2	0	11
Pictorial	68	0	4	2	0	2	3	1	0	12
Grade 11	69	2	0	1	3	1	1	1	3	11
High	70	1	0	5	0	2	3	1	0	9
Male	71	0	6	0	0	0	5	0	1	12
Verbal	72	6	0	0	0	6	0	0	0	12
Grade 11	73	1	3	0	2	4	0	1	1	11
High	74	0	4	1	1	3	2	1	0	11
Female	75	0	6	0	0	1	2	3	0	12
Pictorial	76	2	0	4	0	4	1	1	0	7

Treatment Group	S	P Like	A Like	N Like	S Like	P Diff	A Diff	N Diff	S Diff	Total Correct Responses
Grade 11 High Female Verbal	77	3	1	0	2	5	0	0	1	11
	78	1	5	0	0	4	2	0	0	11
	79	1	4	1	0	3	1	1	1	12
	80	0	6	0	0	1	4	0	1	12
Grade 11 Low Male Pictorial	81	0	5	0	1	5	0	1	0	12
	82	1	2	1	2	5	0	0	1	9
	83	0	2	0	4	0	3	2	1	12
	84	0	6	0	0	1	2	3	0	12
Grade 11 Low Male Verbal	85	2	4	0	0	3	3	0	0	12
	86	0	6	0	0	4	0	1	1	10
	87	0	2	4	0	0	4	0	2	11
	88	3	0	3	0	5	0	1	0	11
Grade 11 Low Female Pictorial	89	4	2	0	0	2	1	3	0	11
	90	3	0	3	0	2	0	4	0	9
	91	0	0	6	0	3	3	0	0	6
	92	2	4	0	0	2	2	2	0	10
Grade 11 Low Female Verbal	93	4	2	0	0	3	3	0	0	11
	94	0	1	2	3	5	1	0	0	11
	95	0	6	0	0	1	3	1	1	12
	96	3	1	2	0	6	0	0	0	12

Task II - Response Data

Treatment Group	S	P	A	N	Total Correct Responses
Grade 5 High Male Pictorial	1 2 3 4	3 6 5 1	2 0 0 2	2 1 2 4	6 7 6 6
Grade 5 High Male Verbal	5 6 7 8	2 1 3 4	0 0 1 3	5 6 3 0	7 6 6 7
Grade 5 High Female Pictorial	9 10 11 12	6 3 2 2	0 2 1 4	1 2 4 1	7 5 5 7
Grade 5 High Female Verbal	13 14 15 16	5 2 3 3	1 4 3 1	1 1 1 3	7 7 6 7
Grade 5 Low Male Pictorial	17 18 19 20	3 3 1 3	4 0 3 4	0 4 3 0	6 6 6 7
Grade 5 Low Male Verbal	21 22 23 24	1 1 4 4	0 5 2 1	6 1 1 2	7 7 6 6
Grade 5 Low Female Pictorial	25 26 27 28	3 2 2 5	2 4 4 1	2 1 1 1	7 6 7 7

Treatment Group	S	P	A	N	Total Correct Responses
Grade 5 Low Female Verbal	29 30 31 32	3 1 6 5	0 5 0 1	4 1 1 1	7 7 7 6
Grade 8 High Male Pictorial	33 34 35 36	1 2 3 2	6 1 0 5	0 4 4 0	7 7 7 7
Grade 8 High Male Verbal	37 38 39 40	3 0 1 3	0 3 1 2	4 4 5 2	7 7 6 7
Grade 8 High Female Pictorial	41 42 43 44	1 4 2 1	5 2 4 2	1 1 1 4	7 7 7 6
Grade 8 High Female Verbal	45 46 47 48	4 2 2 4	0 3 4 3	3 2 1 0	6 7 7 7
Grade 8 Low Male Pictorial	49 50 51 52	1 3 4 3	1 0 0 3	5 4 3 1	6 7 7 5
Grade 8 Low Male Verbal	53 54 55 56	1 5 6 1	4 1 0 6	2 1 1 0	7 5 7 7
Grade 8 Low Female Pictorial	57 58 59 60	3 4 3 2	0 0 2 0	4 3 2 5	7 6 7 5

Treatment Group	S	P	A	N	Total Correct Responses
Grade 8 Low Female Verbal	61 62 63 64	3 1 1 2	2 1 4 4	2 5 2 1	6 6 5 7
Grade 11 High Male Pictorial	65 66 67 68	2 3 2 2	5 3 2 2	0 1 3 3	6 7 7 6
Grade 11 High Male Verbal	69 70 71 72	4 1 1 7	0 2 2 0	3 4 4 0	6 7 6 7
Grade 11 High Female Pictorial	73 74 75 76	4 5 3 3	1 1 0 0	2 1 4 4	7 7 6 6
Grade 11 High Female Verbal	77 78 79 80	3 2 2 0	0 2 1 0	4 3 4 7	5 7 6 5
Grade 11 Low Male Pictorial	81 82 83 84	5 5 2 2	2 1 2 3	0 1 3 2	7 7 7 6
Grade 11 Low Male Verbal	85 86 87 88	0 0 3 0	5 1 0 1	2 6 4 6	7 5 5 5
Grade 11 Low Female Pictorial	89 90 91 92	3 1 1 2	0 0 5 1	4 6 1 4	4 3 7 6

Treatment Group	<u>S</u>	P	A	N	Total Correct Responses
Grade 11 Low Female Verbal	93 94 95 96	3 5 2 7	1 0 2 0	3 2 3 0	6 7 7 5

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