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A developmental study of concept formation in grade-school children.

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A DEVELOPMENTAL STUDY OF CONCEPT FORMATION IN GRADE-SCHOOL CHILDREN

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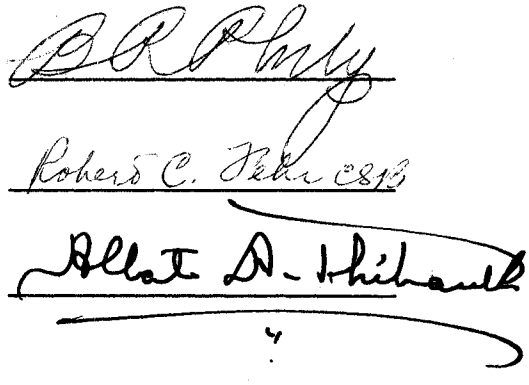

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ABSTRACT

The present study investigated the development of concept formation in grade-school children when such variables as grade, sex, and social status were controlled. Two hundred and seventy-five children in Grades I, II, IV, VI and VIII were given a concept formation test. The main variables studied were: 1) the ability to abstract and generalize; 2) the ability to shift from one concept to another; 3) the sorting time in seconds required to form concepts; 4) the ability to name the concept; and 5) the ability to learn a concept.

It was found that age, as inferred from grade, is the single most important factor in determining whether form, color, or size is the basis of the sorting. For the first sorting, form is preferred to color in increasing amounts corresponding to grade. However, when children are asked to make a second sorting, color is the predominating choice, and females were significantly better than males in Grades I and II. The ability simply to abstract and to generalize along one dimension is well developed by the age of six. The ability to shift from one concept to another seems to develop between Grade VI (mean age: 11.4 years) and Grade VIII (mean age: 13.4 years), for at this time the capacity to make a second sorting, mainly by the abstraction of color, seemed fully developed, and a third sorting, using size primarily, showed a considerable increase. In all grades, the sorting time in seconds for males was faster than for females, and there was a

decreasing sorting time from the first to the second sorting. Form, the main basis for the first judgment, necessitated a longer sorting time than did color, which was the most frequent choice for a second judgment. Size, mainly serving as a basis for a third judgment, required the longest sorting time.

The ability to name or verbalize the concept improved with grade, and the ability to sort developed faster than the ability to give verbal explanations for groupings. It was found that the naming of color and size is done equally well by both boys and girls and is almost perfect after Grade I. Combining the results for Grades I and II, females named form significantly better than males. The naming ability for form in both sexes is practically perfect at Grade IV (mean age: 9.9 years). The results indicated that general naming improves with grade. Girls are significantly better than boys for the general naming of form when the results for all grades are combined. Boys are significantly better at the general naming of color than they are for form.

The learning ability improved with grade. The results indicated that in Grades I and II, ten per cent of the subjects learned, while in Grades IV, VI and VIII, about fifty per cent of the children learned to sort into a third category.

PREFACE

An interest in children and a desire to follow the suggestion of Gordon Allport recommending that more attention be directed to the understanding of the normal person prompted this research. The study by Reichard, Schneider, and Rapaport in 1943, served as the major reference. It was hoped that this work would contribute towards the arrival of norms for the development of concept formation in grade-school children.

The writer wishes to express his appreciation to Brother R. Philip, FSC, Head of the Department of Psychology, for his guidance in the research and, more so, for his patience and understanding. He wishes to acknowledge his gratitude to Sister Marian Dolores, SNJM, Department of Psychology, and to Dr. A. Thibault, Department of Modern Languages, who acted as readers and critics of this work. The writer would also like to thank Brother Alban, FSC, Principal of St. Gabriel's Separate School, without whose cooperation this study could never have begun; to the teachers at St. Gabriel's for their splendid assistance and, especially, to the children who served as subjects, the writer's thanks are also expressed.

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CHAPTER I

INTRODUCTION

Defining Concept Formation

There is no general agreement among theorists as to the meaning of concept formation. English (1961, p. 104) gives a dictionary definition of a concept as:

> 1. Any object of awareness together with its significance or meaning; anything that one can think about that can be distinguished from other things; 2. Knowledge that is not directly perceived through the senses but is the result of a manipulation of sensory impressions. A concept requires both abstraction and generalization; the first to isolate the property, the second to recognize that it may be ascribed to several objects.

Osgood (1953, p. 666) defines a concept as a "common response (usually verbal) made to a class of phenomena, the members of which display certain common characteristics." He believes that when human beings think, they use concepts which may be quite concrete (e.g., tree) or quite abstract (e.g., gravity).

Hilgard (1953, p. 315) defines a concept as:

> a symbol which stands for a class of objects or events with common properties. Words and signs both stand for concepts of varying degrees of generality. As concepts become more general, they become more abstract; that is, they lose the thing character that ordinary objects possess. Concepts of number are more abstract than concepts of color because color inheres in things.

Rapaport (1945, p. 387) states that, from the point of view of logic, the

meaning of concept formation is "the relationship between the concept 'table' and the actually existing tables of our world." Rapaport goes on to say:

> From a logical viewpoint, the naming or identifying of anything must be considered "conceptualization". Language consists of a manipulation of such naming. Thus the very realm of language is pervaded by conceptualization. Since verbal thinking has been accepted as abstract symbolic thinking, words being considered symbols for things, we must realize that any symbolization is in a sense conceptualization.

Theories of Concept Formation

Hull (1920) believes that concept formation consists in finding the common elements in a group of stimuli. In so far as he and others who agree with him are concerned, the common element is the concept.

Smoke (1932) comments that:

> Hull's viewpoint is an oversimplification in that it deals not with the entire process of concept formation but only with that aspect of it commonly known as abstraction, the process whereby a young child forms the concept "dog". Hull's examples are not merely those of locating an identical common element in a group of stimuli. As the child learns more and more about dogs his concept of dog becomes richer, not a closer approximation of some bare common element. Concept formation involves synthesis as well as analysis.

Smoke sets up his bio-social criterion for determining whether a S has learned a concept. The standard is "the consistency with which he is able to make symbolic responses that differentiate the members of a class of stimulus patterns in question, or an aspect of that class from other stimuli." (1935, p. 275). As far as Hull, Smoke, Heidbreder, and others are concerned, concepts may not necessarily be conscious. Also, these theorists believe that there are certain Ss who are able to acquire the correct conceptual response but may not be able to verbalize the underlying principle of generalization. As will be seen, Goldstein agrees

with this latter point but insists that the concepts necessarily be conscious.

The aforementioned approaches to concept formation may be called experimental or quantitative. Let us turn now to a non-experimental, qualitative or descriptive method of studying concept formation. Piaget (1960, p. 37) recognizes four stages in the development of a concept in a child. The first stage is presymbolic and consists in the fact that the child has learned to react in characteristic ways to a particular object. In the next stage, the child employs a symbol, usually a word, that stands for a particular object but not for a class of objects. In the third stage, the child is capable of implicit responses that are symbolic of the class in question, but he is unable to give a satisfactory verbal formulation of the concept. The final stage is evidenced by the child's ability to organize objects in groups.

Another theorist whose works have been major contributions to the study of concept formation is Goldstein. Like those of Piaget, his studies are on a descriptive, qualitative level.

Goldstein noted that people with abnormalities such as brain damage and schizophrenia operate on a concrete rather than an abstract level. For Goldstein (1941),

> . . . the concrete attitude is realistic. It does not imply conscious activity in the sense of reasoning, awareness, or a self account of one's doing. We surrender to experience of an unreflective character: we are confined to the immediate apprehension of a given thing or situation in its particular uniqueness. This apprehension may be by sense or percept but it is never mediated by discursive reasoning. Our thinking and acting are directed by the immediate claims which one particular aspect of the object or of the outer world makes. Most of our common reactions are co-determined by the claims arising from the environmental stimuli in our every day life. Such a claim may constitute a bond between the responding individual and the object.

> Because of the bondage, the individual cannot easily detach himself from the demand exerted by that experienced uniqueness of the object. Therefore, it is difficult, if not impossible, for him to realize other potential functions of this same object, or even to conceive of it as an example, a representative, or a case of a general class or category. The dependence upon immediate claims can take on the characteristic of rigidity and 'lack of shifting', well known in abnormal psychology.

The abstract attitude for Goldstein (1941, p. 3),

> embraces more than merely the real stimulus in the scope. It implies conscious reasoning, awareness, and self-account of one's doing. We transcend the immediately given situation, the specific aspect or sense impression: we abstract common from particular properties; we are orientated in our action by a rather conceptual viewpoint, be it a category, a class or a general meaning under which the particular object before us falls. We detach ourselves from the given impression; the given impression and the individual thing represents to us an accidental example or representation of a category.

Goldstein is opposed to those theorists such as Hull who claim that, in identifying the common elements, one has made an abstraction. This is why he gives importance to the shifting of concepts and verbalization. He agrees with these theorists that, although verbalization is an index of a higher level of abstraction, it is not characteristic of every abstraction. Concept formation then, as postulated by Goldstein (1941, p. 24), refers to "a genuine abstraction bound to a conscious and volitional act of reflecting upon the properties of objects with reference to a concept, a class, a category."

Sorting Tests for Determining Abstraction

Goldstein (1941) describes five tests which he has devised for the testing of abstract ability. The test which most approximates the one used in this investigation is the Weigl-Goldstein-Schreerer Color-Form Sorting Test. The

test is used with abnormals and its purpose is to determine whether the subject is able to sort a given variety of differently colored figures according to the categories of color and form. This test is described (p. 114) as follows:

> The materials for this test consist of 12 pieces, including 4 circles, 4 squares, and 4 triangles, each shape occurring in red, green, yellow and blue. The 12 pieces are presented to the subject in random order, with the instruction to place together those that belong together. Upon completion of the task, the subject is asked to sort the pieces in another way. If the subject does not spontaneously sort the pieces according to form and color, a number of aids are provided to facilitate the task, as in the Cube Test. In this test, interest is focused on the subject's ability to shift from one basis of classification to another.

It is important that the subject abstract color or form as a conceptual principle of sorting. Also, he must account for his grouping by naming or verbalizing the underlying principle of generalization. Some abnormal patients indicate a tendency to build patterns. Abstractly, they cannot single out the common properties; hence the only means of responding is to deal with the figures concretely by "doing" something with them in a concrete way. The patient solves the problem of sorting by doing. In this process of "doing", (Goldstein, 1941, p. 114)

> which is guided by the dominant sense impressions, the patient becomes subjected to the configurational valences as they arise from the figures placed and from their perceptual influence so that the pattern emerges during and by virtue of the activity of placing one figure after the other. The subject who persists in a pattern arrangement under these circumstances has to be considered abnormally concrete - unless other control experiments should bring about results which justify this behavior as a volitional action.

In the present study, children in the early grades showed a strong tendency to build patterns. For example, if on the first sorting the designs were ordered according to form and a second sorting was called for, many of the

children, unable to find a new grouping principle, would order the blocks again according to form, but they would "do" something different. Perhaps, if on the first sorting, the triangles were placed one on top of the other, with the largest one on the bottom, then, on the second sorting, the order was simply reversed by placing the largest triangle on top of the pile. This procedure of "doing" something with designs seems to be characteristic both of young normal children as well as of abnormal patients.

A patient's inability to shift from one concept to another is indicative of a rigidity, in the sense that he is controlled by one set of stimulus impressions. Goldstein (1941, p. 126) writes:

> This impairment of the categorical attitude entails the incapacity to generalize in two directions. First, the patient can neither reflect upon nor conceptualize his "doing" and arrive at any category or principle. Secondly, most of the patients form groups of either kind, shape or color according to the experimentally produced shifts forced upon them. But, this is no way to help a patient to learn from his own doings what the task demands. The patient is unable to generalize - that is - to apply the meaning of a once-attained result to other situations. In most cases, the patients grouped the shapes at least once during the test. This did not result in a sorting according to form under the other presentations and if it were attained, then it was with a rigidity which could not be attained thereafter. Thus, the test result is not only an indicator of the patient's potentiality to form a concept but also of his ability to learn.

In a criticism of the Goldstein tests, Kogan (1949, p. 42) writes that "these tests do pick out a group of patients - cerebral pathology - but that in reality many patients with various forms of cortical defect exhibit no impairment of the abstract attitude." She further criticizes Goldstein because his experimental studies present only qualitative results and because all data pertaining to standardization is lacking. Also, any statement as to the extent or

frequency with which normal variability might introduce concrete elements into the response of essentially healthy persons is omitted. Also, there is no systematic method of scoring or evaluating test performance. The tests become valid only when the patients experience difficulty with all items, for with partial success there are no norms for interpretation.

The Hanfman Kasanin Test of Concept Formation (1937), which is an extension of the Vigotsky Concept Formation Test is a sorting test in which,

> The subject is told that there are four different kinds of blocks: that each kind has a name and that his task is to find the four kinds and to put each of them into a separate corner. The subject is asked to formulate the principle of classification. The principle is one of double dichotomy; large or small; and tall or flat. The test classification is based on not one but two characteristics, which in their combination yield to sub-classes; large-tall, large-flat, small-flat, small-tall. The concepts to be found are not supported by already existing names which the subject may have ready at hand in the same way as he has red, round, etc.: nor is there any general name for the combination of height and size on the top surface. Thus, it is impossible for the subject to reach a solution in a pseudo-conceptual way by merely operating with words.

In this regard, Rapaport (1945, p. 392) writes:

> while Similarities and the Sorting Test is a test of everyday concept formation, the Hanfman-Kasanin Test may be considered a test of basic concept formation -- that is, concept formation in productive action, rather than the chore of reproducing previous verbal or experimental stereotypes. . . . Insistence on performance and verbalization and inquiry into every doubtful shading of either is the only method whereby diagnostic concept formation testing can be practised.

The Specific Problem

The specific problem at hand is to determine levels of conceptual development in grade school children. In this experiment the subject must choose among three alternatives: he may sort the blocks according to form, color, or size.

Hilgard states the problem clearly. He believes that in studying concept formation we are concerned with the subject matter of problem solving. The subject tries to discover what there is in common among a number of figures or objects. His task is to separate out from all of the stimuli, aspects that are crucial to the concept. Were he unable to abstract the common properties of things, or to generalize about classes of objects, he would be greatly handicapped and could not reach the higher levels at all.

Survey of the Literature

One of the first major studies on the contents of children's minds was begun in October, 1869, by the Pedagogical Society in Berlin under the direction of Hall. The purpose of the study (1948, p. 255) "was to ascertain how many of the children who entered the primary classes that fall had seen and could name certain common animals, insects and plants, etc." The results showed that the concepts which are most common in the children in a given locality are the easiest to be acquired. He also felt that it was extremely important to familiarize children with objects first.

Two developmental studies which are almost identical in method and results were by Descoudres in 1914 and by Brian and Goodenough in 1929. The results of the Brian and Goodenough study showed that children below three years of age match on the basis of form; children between three and six match on the basis of color; and children above six to adulthood match on the basis of form. Marked age differences in the relative potency of form and color as indicated by the matchings were found. The explanation given in the Brian and

Goodenough paper is as follows:

> The child first responds to elements which are common to many features of the environment; next is a preoccupation with those attributes of a given object or situation which makes for differentiation of species within a given genus; the final swing towards form is the result of various attributes of a given situation in terms of those factors which experience has shown are most frequently effective in determining appropriateness of response.

Closely related to these two studies is an experiment conducted by Lindberg who used for his subjects 2,446 elementary school children and 218 adult brain-damaged patients. Two tests were constructed by the author, a so-called ring test and a sorting test. The results showed that the tendency to color response decreases with age in elementary school; there seemed to be an inverse correlation with intelligence; in all age groups girls seemed to have a somewhat lower degree of color attitude than boys. This difference between the sexes was discovered in both tests and is also found in both adult mental patients in the normal group.

The research paper by Thompson (1941) is most appropriate to our present study. The apparatus used was the Weigl Color-Form Test, the BRL Test which is a modified Weigl Sorting Test and the Vigotsky Concept Formation Test. These tests were administered to sixty grammar school children in grades one to six (ten in each group). The results are as follows: on the Color-Form Test, all children could sort in one category and 40% could sort in two categories. All those who chose categories gave some reason for their sorting but only half of the responses were generalizations (form, color, shape). More of the older than of the younger children generalized but both groups gave significantly more

color generalizations than form generalizations. More older than younger children sort for both categories. Children usually generalize color before form, although Piaget, Buhler, Terman and associates, who standardized the Stanford Binet Intelligence Test, stated that the ability to generalize did not develop in the child before the eleventh or twelfth year. Thompson's study showed that there was a definite qualitative and quantitative change in the ability to generalize or to handle abstractions between the age range of "6-8 and 9-11 years". Younger children tended to form groups of objects related in specific concrete situations, or to see fewer general relationships between objects. Older children were constantly more concerned with differences between objects than with their similarities. Apparently then, the younger children were unable to overlook discrepancies and to take into account underlying similarities. Only when a child is able to grasp certain relationships between objects is he able to learn and use a word signifying that relationship. The ability to apply a class name in a categorical way presupposed the ability to grasp the characteristics of the class. This supposed that younger children did not have a general name in their vocabulary or that, if they had a class name, it did not have the same meaning for them that it had for older children.

In 1943, Reichard, Schneider and Rapaport conducted an experiment which most nearly approximates this study. Their purpose was to supply a set of developmental norms for the evaluation of clinical anomalies. The subjects, 234 normal white children of the ages 4-14, were given the Color-Form and the Sorting Tests of Weigl, Goldstein, and Scheerer. In the Color-Form Test, the scoring of verbal behavior was based on the somewhat arbitrary assumption that

we may distinguish among three main methods of forming concepts. Of these, concept formation on the basis of non-essential incidental features is the most primitive; concept formation on the basis of function or use, which we shall call functional description is the next, and general abstract conceptual definition is the highest.

The results were as follows: Children below five do not shift from a grouping principle they have once conceived, probably due to perceptual dominance (in this case, the possibility that form is more easily perceived than color) as well as the inability to shift. Around seven to eight years of age, the ability to perform two groupings appears to become predominant, and children above eight years meet even Piaget's criterion of success inasmuch as 75% or more are able to do both color and form groupings or, in Goldstein's terms, "are able to shift from one grouping principle to another." The children above five years are inclined to sort more in terms of form than in terms of color. There is a steady increase in the number of correct responses and of conceptual definitions which follows the normal growth curve and reaches a plateau at about nine years. Comparison of the scores for grouping and verbalization reveals that grouping ability develops faster than does the ability to give verbal explanations for one's grouping, thus confirming Piaget. While extremely loose groupings are found in very young children, thus attesting to the amorphous nature of concepts at this early age, mildly loose groupings, which included one or two objects not strictly within the bounds of the concept, on the other hand showed a sharp rise at adolescence. It was found that the functional level of conceptual

development begins when the children make their first relevant classification, which they do mainly in terms of what use the objects are to them. This functional level of concept formation reaches its peak in children of eight and nine, after which it is gradually replaced by more mature, conceptual classifications. This last stage seems to reach relative maturity in children of around sixteen years of age.

CHAPTER II

METHODOLOGY AND PROCEDURE

The apparatus used in testing the subjects was portable and simple in design. It comprised three triangles, three squares and three hexagons varying in color and size as can be seen in Figure 1 (Appendix A); these designs were numbered on the back for the purpose of quick recording on the scoring sheet.

The subjects entered the room individually and the experimenter did his best to make each one feel comfortable. The apparatus was displayed randomly before the subject. The sheet of square paper which covered the design was withdrawn and the instructions for the first sorting began as follows: "Under this square sheet of paper I have nine plastic blocks. Look at these nine blocks and place the ones that belong together in piles." If the subject was unable to proceed, the instructions were clarified as follows: "Look at these nine blocks and place together in piles the ones that are similar or are the same for any reason." If the instructions were still not clear, the clarifying statement was reiterated. As the subject proceeded, the experimenter, after each sorting was completed, recorded the time required to make the first sorting as well as the method of sorting the designs. Then the testee was asked to state his reason for placing certain designs together - the purpose of this step being to discover whether the subject could verbalize his concept or not. As an example, the student might reply that he placed the designs together because they were the same shape.

With the designs again randomly mixed, the instructions for the second

sorting were as follows: "This time I want you to look at the nine designs and try to find a completely different way of placing the blocks that belong together in piles." These instructions were clarified in the following manner: "You have found one way of placing together in piles blocks that are similar or that belong together. This time, try to find a completely different way of placing blocks that belong together in piles." These same instructions were repeated if further clarification was necessary.

The designs were rearranged for the third sorting with the instructions as follows: "This time, I want you to look at the nine blocks and try to find one other completely different way of placing blocks that belong together in piles." If necessary, further elucidation followed: "Now you have found that there are two completely different ways of placing blocks that belong together in piles. I want you to try to find one other completely different way of placing blocks that belong together in piles." These instructions were repeated if it was necessary.

If in either the second or third sorting, the subject was unable to proceed further with the test, a fourth part of the experiment was designed to evaluate the subject's learning ability. For example, if on the first sorting the designs were ordered according to shape and the subject could proceed no further, he was then shown how to sort by color. On the basis of this demonstration, it was expected that the subject would proceed to sort the blocks by the dimension of size. Table 1 illustrates the order of demonstrations for the sorting, depending on whether shape, color, or size was used in making the first sorting.

Finally, if the subject made two perfect sortings, and could proceed

no further, the principles by which he made these two sortings were re-explained to the subject and demonstrated by remaking his sortings.

Table 1

Order for the Demonstrations

Sorting	Demonstration	Learning
Shape	Size	Color
Color	Size	Shape
Size	Color	Shape

CHAPTER III

ANALYSIS OF RESULTS

The present results were analyzed under three main headings: 1) the percentage of sortings to form, color, and size; under each of these three categories the median number of sortings and the median sorting times in seconds for boys and girls were determined; 2) the naming of each category by boys and girls, which was subdivided into general and particular naming; 3) the ability of both sexes to learn to sort into a new category.

Sorting Ability

One of the main purposes of this experiment was to determine whether form, color, or size was preferred by males and females when first, second, and third sortings were demanded. Grade, as indicative of age, appeared to be the single most important factor in determining whether form, color, or size be abstracted first. Fig. 2 (Appendix B) clearly shows that from Grade I on, form was preferred over color in increasing amounts. Data from Table 2 shows that, except for the girls in Grade I whose choices of form and color in making their first judgment were fairly equal, form was increasingly preferred in all grades by both sexes. As Fig. 3 (Appendix C) indicates, when the children were asked to make a second judgment, color was most frequently chosen, since form had already been highly preferred as a first choice and, as shown in Fig. 4 (Appendix D) or Fig. 5 (Appendix E), the selection of the category "size" rarely appeared before Grade VIII.

Table 2

Frequency of Judgments as to Form, Color, Size

	MALE				FEMALE				BOTH			
	F	C	S	T	F	C	S	T	F	C	S	T
Grade I		N = 49				N = 34				N = 83		
Sortings												
1	29	13	2	44	14	13	--	27	43	26	2	71
2	6	5	--	11	3	4	1	8	9	9	1	19
3	--	--	--	--	--	--	1	1	--	--	1	1
Grade II		N = 30				N = 32				N = 62		
Sortings												
1	22	7	--	29	22	7	--	29	44	14	--	58
2	2	2	1	5	3	4	2	9	5	6	3	14
3	--	--	--	--	--	--	1	1	--	--	1	1
Grade IV		N = 19				N = 29				N = 48		
Sortings												
1	15	1	--	16	24	--	2	26	39	1	2	42
2	1	3	--	4	1	7	1	9	2	10	1	13
3	--	--	1	1	--	--	2	2	--	2	3	5
Grade VI		N = 22				N = 16				N = 38		
Sortings												
1	16	2	--	18	15	--	--	15	31	2	--	33
2	1	8	--	9	--	1	2	3	1	9	2	12
3	--	--	2	2	--	2	1	3	--	2	3	5
Grade VIII		N = 44										
Sortings												
1	36	5	1	42								
2	4	26	5	35								
3	1	4	9	14								

As is shown in Fig. 6 (Appendix F), the ability to categorize improved with grade. Girls in Grades II, IV and VI made a greater number of sortings than did boys. In Grades II and IV this difference was due mainly to the greater ability of females to make a second sorting for which color was almost always used. Table 3 shows the median number of correct sortings for both sexes.

Table 3

Median Number of Correct Sortings for Male and Female Subjects

Grade	Male	Female	Both
I	1.12	1.07	1.10
II	1.11	1.19	1.16
IV	1.12	1.35	1.27
VI	1.24	1.36	1.29
VIII	1.66		

Table 4 indicates that in all grades the sorting time for males was faster than for females. The sorting time from the first to the second sorting diminished with grade. As is shown in Table 5, color is the category that is most quickly sorted. All the above findings are statistically significant at the five per cent level or better, when the formula for significance of a difference in percentage is used.

Table 4

Median Sorting Time in Seconds

	MALE				FEMALE				TOTAL			
	F	C	S	T	F	C	S	T	F	C	S	T
Grade I												
Sortings												
1	5.5	3.5	4.0	4.84	5.0	5.0	-	5.00	5.5	5.0	4.0	5.27
2	3.0	2.5	--	2.77	1.5	4.0	7.0	3.44	2.0	3.5	7.0	2.97
3	--	--	--	--	--	--	2.0	2.00	--	--	2.0	2.00
Total	5.07	3.22	4.00	4.43	4.38	4.76	4.50	4.57	4.89	4.61	4.25	4.76
Grade II												
Sortings												
1	6.0	4.0	--	5.52	7.0	4.0	--	6.28	7.0	4.0	--	6.28
2	1.5	3.0	1.5	2.10	2.5	3.0	3.0	2.83	2.0	3.0	2.5	2.54
3	--	--	--	--	--	--	12.0	12.00	--	--	12.0	12.00
Total	5.58	3.77	1.50	5.01	6.46	3.63	6.00	5.63	6.69	3.30	4.88	5.64
Grade IV												
Sortings												
1	4.5	1.0	--	4.28	5.5	--	6.0	5.54	5.0	1.0	5.0	4.90
2	4.0	1.0	--	1.75	3.0	3.0	2.0	2.88	3.0	2.0	2.0	2.15
3	--	--	4.0	4.00	--	4.0	2.0	3.00	--	4.0	3.0	3.40
Total	4.47	1.00	4.00	3.79	5.40	3.22	3.60	4.66	4.90	2.23	3.50	4.18
Grade VI												
Sortings												
1	6.0	1.0	--	5.41	8.0	--	--	8.00	7.0	1.0	--	6.62
2	2.0	2.0	--	2.00	--	12.0	2.0	5.33	2.0	2.0	2.0	2.00
3	--	--	2.0	2.00	--	2.0	60.0	21.33	--	2.0	6.0	4.40
Total	5.75	1.82	2.00	4.00	8.00	5.33	21.33	9.52	6.84	1.86	4.40	5.20
Grade VIII												
Sortings												
1	4.0	2.0	3.0	3.74								
2	3.0	3.0	3.0	3.00								
3	3.0	2.0	17.5	12.03								
Total	3.88	2.74	11.70	4.73								

Table 5

Average of the Median Sorting Times

	Male	Female	Both
Form	4.95	6.07	5.45
Color	2.53	2.53	3.28
Size	4.64	4.64	6.51

Naming Ability

The ability to name the category which had been sorted improved with grade, as seen in Fig. 7 (Appendix G). From Table 6 it is seen that females named form significantly better than did males. The naming ability for both males and females was almost perfect from Grade IV on. Girls in all grades gave general names for form significantly better than did the boys, as is shown in Table 7. When the results for all grades were combined it was found that boys gave significantly more general names for color than they did for form. All results reported were statistically significant in this section.

Learning Ability

Because there was no sampling procedure used in choosing the subjects tested for learning, the following results are presented only for the purpose of indicating a trend. Possible subjects for the learning test were any children who failed to make three perfect sortings. The results are given in Table 8.

Table 6

Ratio of Naming to Sortings According to Sex and Category

	MALE			FEMALE		
	F	C	S	F	C	S
Grade I - 1	.457	.833	1.000	.765	.765	1.000
- 2	.188	.400	1.000	.583	.615	.500
Grade II - 1	.583	1.000	1.000	.760	1.000	1.000
- 2	.286	.777		.597	.727	
Grade IV - 1	1.000	1.000	1.000	.960	1.000	1.000
- 2	.375	.500		.666	.777	.800
Grade VI - 1	1.000	1.000	1.000	1.000	1.000	1.000
- 2	.188	.400	.500	.333	1.000	.666
Grade VIII -1	1.000	.971	1.000			
-2	.390	.765	.200			

1 - Ratio of Total Naming to Total Sorting
2 - Ratio of General Naming to Total Sorting

Table 7

Ratio of Total and General Naming to Sorting

	Total Naming					General Naming		
Grade	a	b	c	d	e	a	b	c
I	61	91	.677	249	.365	27	91	.297
II	57	73	.781	186	.392	30	73	.411
IV	59	60	.983	144	.416	35	60	.583
VI	49	49	1.000	114	.429	18	49	.367
VIII	90	91	.989	132	.689	45	91	.494

a - Number of times categories were named. b - Number of Sortings
c - Ratio of Naming to total Sorting (a/b). d - Possible number of Sortings.
e - Ratio of naming to all possible Sortings (b/d)

Table 8

Learning According to Sex

Grade	MALE			FEMALE			BOTH		
	A	B	C	A	B	C	A	B	C
I	49	18	3	34	12	0	83	30	3
II	30	11	1	31	10	1	61	21	2
IV	18	5	1	29	9	6	43	14	7
VI	20	13	5	13	7	5	33	20	10
VIII	21	21	11	-	-	-	21	21	11

A - Total possible number of subjects for the testing of learning.
B - Total number of subjects tested.
C - Total number who succeeded in learning.

Approximately one-third of the subjects was tested in Grades I, II, and IV; two-thirds in Grade VI; and all of the possible subjects in Grade VIII. It was found that the learning ability did improve with grade. In Grades I and II, only about ten per cent of the subjects tested learned, whereas in Grades IV, VI and VIII, about fifty per cent of the subjects tested learned.

CHAPTER IV

DISCUSSION OF RESULTS

In order to evaluate the results properly, a brief review of the various theories of concept formation is necessary. English (1961, p. 105) stated that the two requirements for forming a concept were abstraction (to isolate the property) and generalization (to recognize that it may be ascribed to several objects.) Osgood (1953, p. 666) maintained that the concept may be quite concrete (e.g., Tree) or quite abstract (e.g., Gravity). Hilgard (1953, p. 315) believed that the concepts are symbols for classes of objects, which become more general as they become more abstract. In so becoming they lose the "thing" character that ordinary objects possess. Piaget (1960, p. 37) recognized four stages in the development of a child's concept. In the third stage, the child is capable of implicit responses that are symbolic of the class in question but he is unable to give a satisfactory verbal formulation of the concept. In the final stage, the child is able to organize objects in groups. Goldstein (1941) differentiated between the concrete and abstract attitudes. In the concrete attitude, the bonds between the individual and the perceived stimuli are so strong that a rigidity or inability to shift concepts results, hindering the individual's recognition of other potential functions of the same object. The response which the individual might make is realistic but unreflective. The abstract attitude implies conscious reasoning and the ability to transcend the immediate situation so that it becomes possible to abstract common from

particular properties. All theorists seem to agree that the naming of the concept is an important part of the ability to think abstractly.

Sorting Ability

The present study concurred with the previous experiments of Descoudres (1914), Brian and Goodenough (1929) and Lindberg (1938), which reported the age (inferred from grade) as being the single most important factor in determining whether form or color be first abstracted. There was further agreement with these studies that from the age of six onwards, form was preferred to color in increasing amounts corresponding to age. Lindberg (1938) also found that color responses decreased with age. In an explanation of similar results found in the study by Brian and Goodenough, it was hypothesized that this final swing is the result of the gradual organization of the various attributes of a given situation in terms of those factors which experience has shown are most frequently effective. In Grade I, it was found that males initially chose form to a greater extent than did females. This finding seems to disagree with that of Brian and Goodenough who claim that there is no consistent sex difference in choosing form over color. Also, the evidence here presented seems to favor the argument that concept formation does not develop through the quantitative addition of bits of information. Rather, it would seem to support the hypothesis of Piaget that the development of concepts comes about through qualitative changes within the individual, at least in the early years.

It was found that the median number of sortings increased with age. In Grades II and IV, females made a greater median number of sortings than did males,

and since form and size were chosen approximately as frequently by both, it was concluded that girls show better generalization ability, at least for color. In this study, then, it was found that the ability simply to abstract and to generalize along one dimension is almost fully developed by the age of six. The ability to abstract in two categories does not seem to develop until the VIIIth grade, when eighty per cent of the subjects demonstrate an ability to do so. Even greater flexibility, as exemplified in the ability to shift from one concept to another, is noted when males showed a significant improvement between Grades VI and VIII in their ability to make a third sorting, mostly according to size. Thus Goldstein's criterion for concept formation, which is the ability to shift, is met by boys between Grades VI (mean age: 11.7 years of age) and Grade VIII (mean age: 13.4 years of age.) These results differ from those reported by Reichard, Schneider and Rapaport (1943) which indicated that, by the age of seven or eight, the ability to perform two groupings is perfected and that real conceptual classifications are attained about the age of eleven. Thompson (1941) reported that there was a quantitative and qualitative change in the abstractions which takes place "between (6-8) and (9-11) years of age." Also, Piaget, Buhler, and Terman and associates, who standardized the Stanford Binet, reported that the ability to generalize does not develop until the eleventh or twelfth year.

The quicker sorting time for males than for females must be explained. It was noted that in Grades II and IV, females made a greater median number of sortings than did males, chiefly because of their greater ability to abstract and generalize color. Also, in Grade I, females chose equally between form and color in making their first judgment. It appears that when a first sorting is called for,

females may be undecided in the early grades as to their preference for form and color and consequently take a longer sorting time. The second sorting is faster than the first, possibly because, after the first sorting, the children have learned just what is demanded of them.

Naming Ability

In this experiment, it was found that the ability to name or to verbalize the concept improves with grade. In Grade I, 68 per cent of the subjects named their method of sorting, whereas in Grade II, 78 per cent of the subjects did so. These results concur with the studies by Piaget (1928) and Reichard, Schneider and Rapaport (1943) which also claimed that the ability to formulate categories precedes the ability to verbalize the concept. There is disagreement with Thompson's study (1941) which reported that all subjects who formed categories gave some reason for it. Thompson also reported that over half of the naming could be called generalizations (e.g., form, color, size.) The present study indicated that girls always give more than fifty per cent generalizations for form and a much higher percentage for color and size. Boys are able to generalize color and size over fifty per cent of the time, but it is noted that even older male students failed to generalize form fifty per cent of the time. Thompson's study also reported that both the older and the younger subjects give significantly more color than form generalizations. The present study corroborates this finding for both boys and girls.

CHAPTER V

SUMMARY AND CONCLUSIONS

Two hundred and seventy-five children in Grades I, II, IV, VI and VIII, ranging in mean chronological age per grade from 6.4 to 13.4 years, were given a concept formation test. The purpose of the research was to study the development of concept formation in grade-school children when grade, sex, and social status were controlled. The main variables studied were: 1) the ability to abstract and generalize; 2) the ability to shift from one concept to another; 3) the sorting time, in seconds; 4) the ability to name the concept; 5) the ability to learn the concept.

It was found that age, as inferred from grade, is the single most important factor in determining whether form, color, or size is the basis of the sorting. Form is preferred to color in increasing amounts corresponding to age, for the first sorting. However, when children are asked to make a second sorting, color is the predominating choice and females do significantly better than males in Grades I and II (beyond the .01 level of confidence). Also, it was found that the ability simply to abstract and generalize along one dimension is almost fully developed by the age of six. The ability to shift from one concept to another seems to develop between Grade VI (mean age: 11.4 years) and Grade VIII (mean age: 13.4 years), for at this time the capacity to make second sortings (mainly by the abstraction of color) seemed to increase, and a third sorting, using size, occurred with

considerably increased frequency at that grade. Piaget's hypothesis that concept formation develops by qualitative changes from within seemed to receive support from the finding that a statistically significant difference was found for both sexes in the preference of form over color as a first judgment between Grades I and II. In all grades, the sorting time in seconds for males was faster than for females, and there was a decreased sorting time from the first to the second sorting. Form, the main basis for the first judgment, necessitated a longer sorting than did color, which was the most frequent choice for a second judgment. Size, serving as a basis for third judgments, required the longest sorting time.

The ability to name or verbalize the concept improved with grade and the ability to sort developed faster than the ability to give verbal explanations for the groupings. It was found that the naming of color and size was accomplished equally well by both boys and girls and is almost perfect after Grade I. Combining the results for Grade I and Grade II, females named form significantly better than males (beyond the .01 level of confidence). The naming ability for form in both sexes is practically perfect after Grade IV (mean age: 9.9 years). The results indicated that general naming improved with age. Girls show a significantly greater ability (beyond the .01 level of confidence) over boys, for the general naming of color than for form.

The learning ability improved with age. Results indicated that in Grades I and II, ten percent of the subjects learned, while in Grades IV, VI and VIII, approximately fifty per cent of the children learned to sort into a third category.

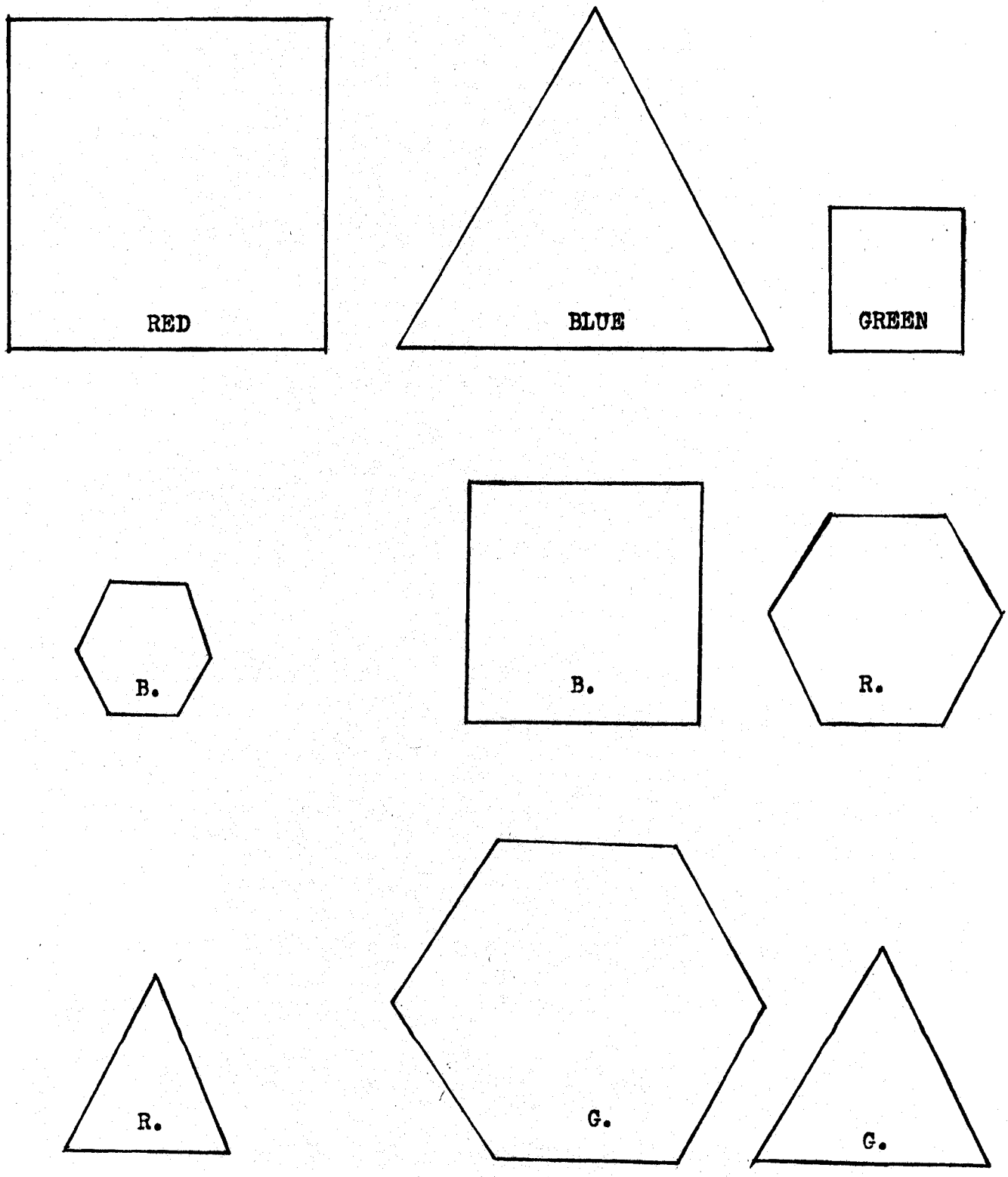


Fig. 1. Example layout for the first sorting.

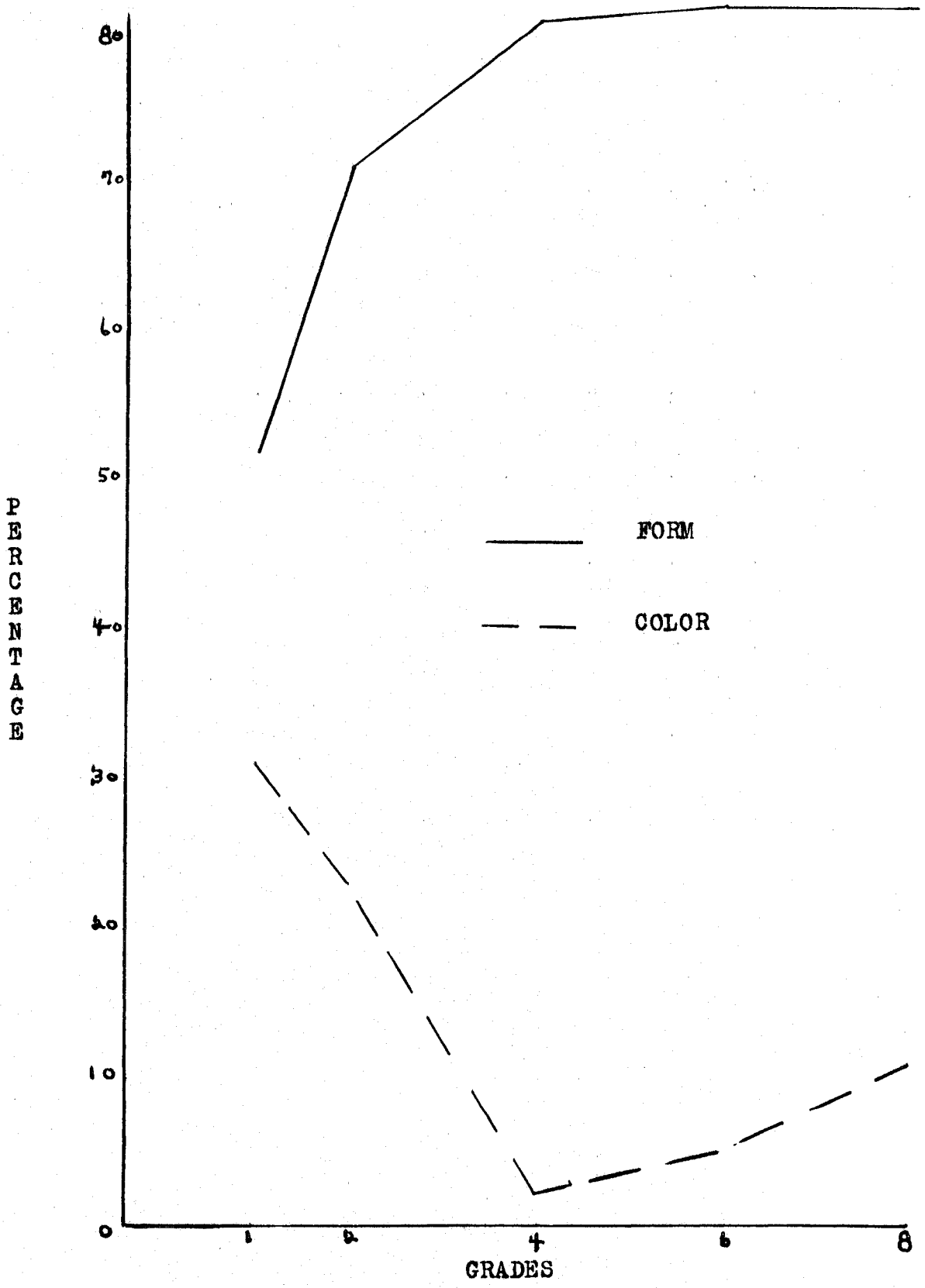


Fig. 2. Percentage of first judgments.

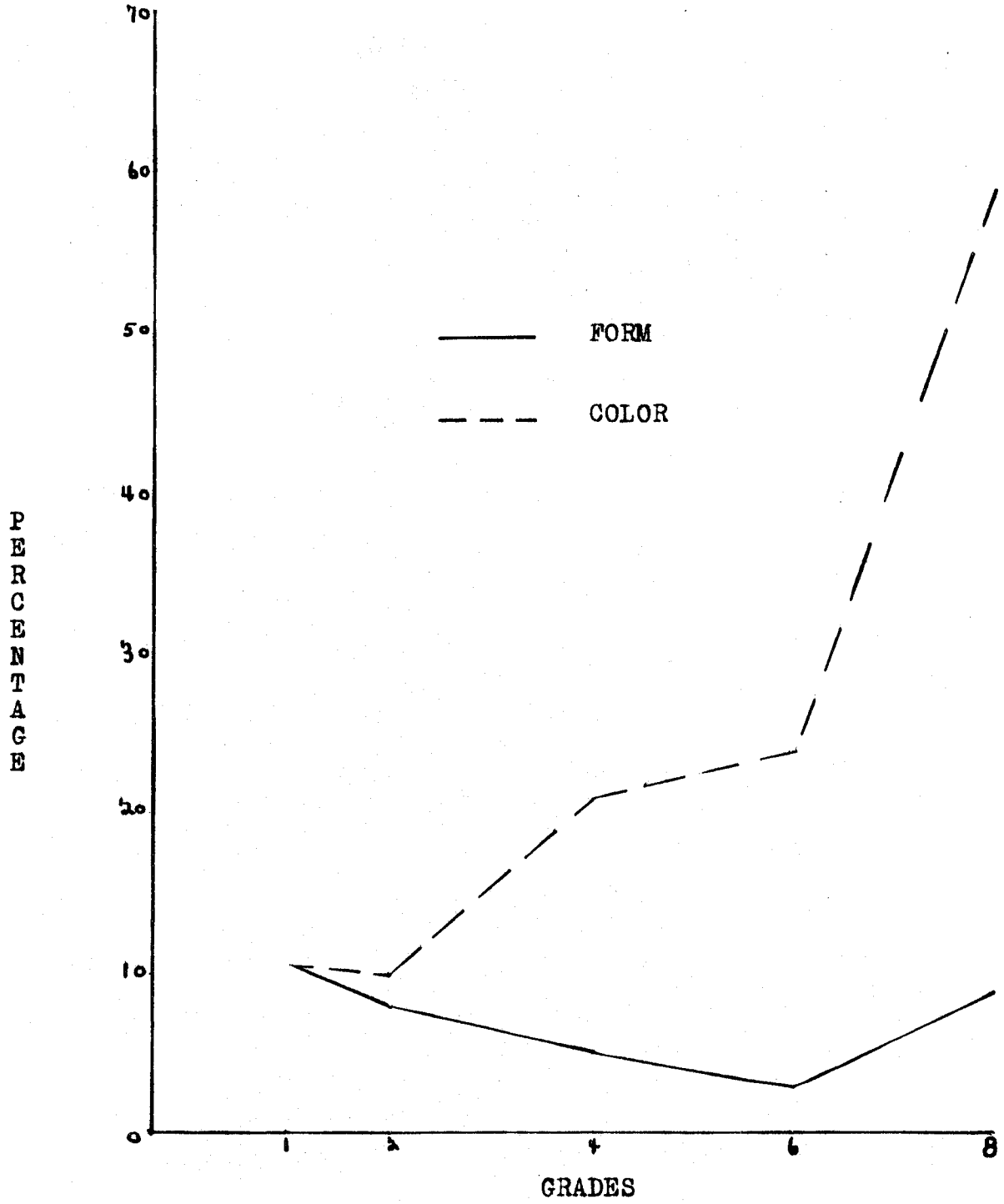


Fig. 3. Percentage of second judgments.

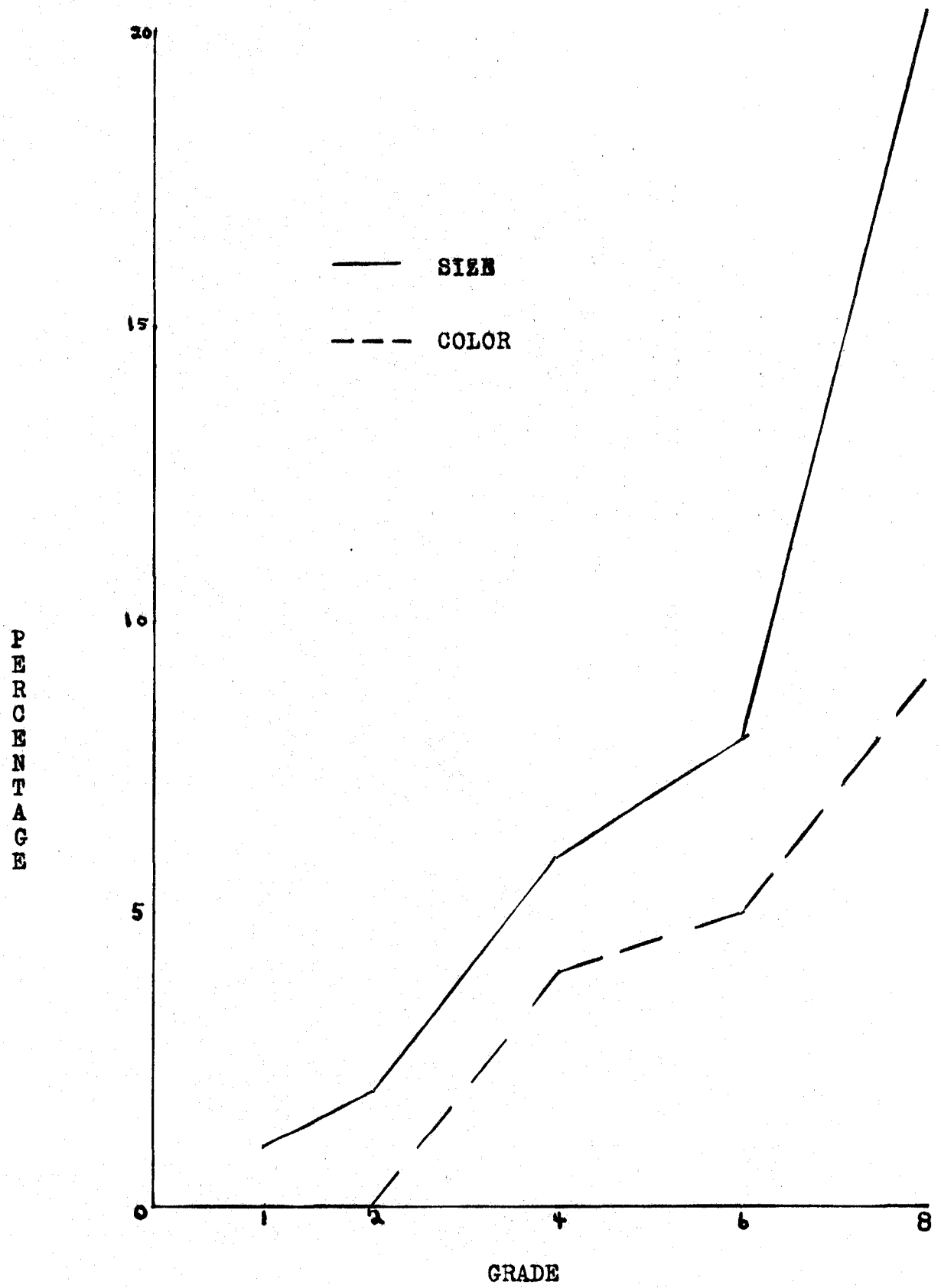


Fig. 4. Percentage of third judgments.

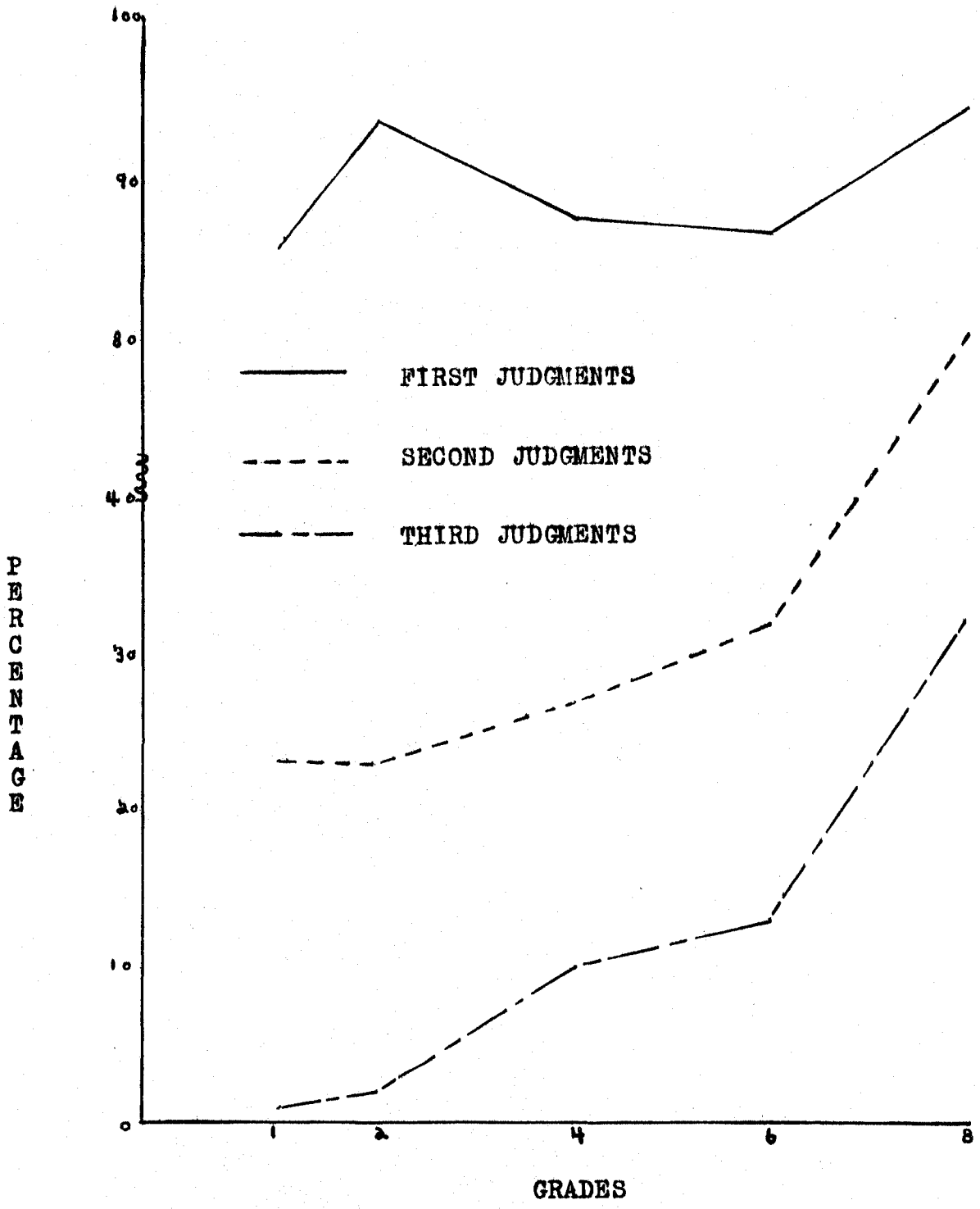


Fig. 5. Percentage of first, second and third judgments.

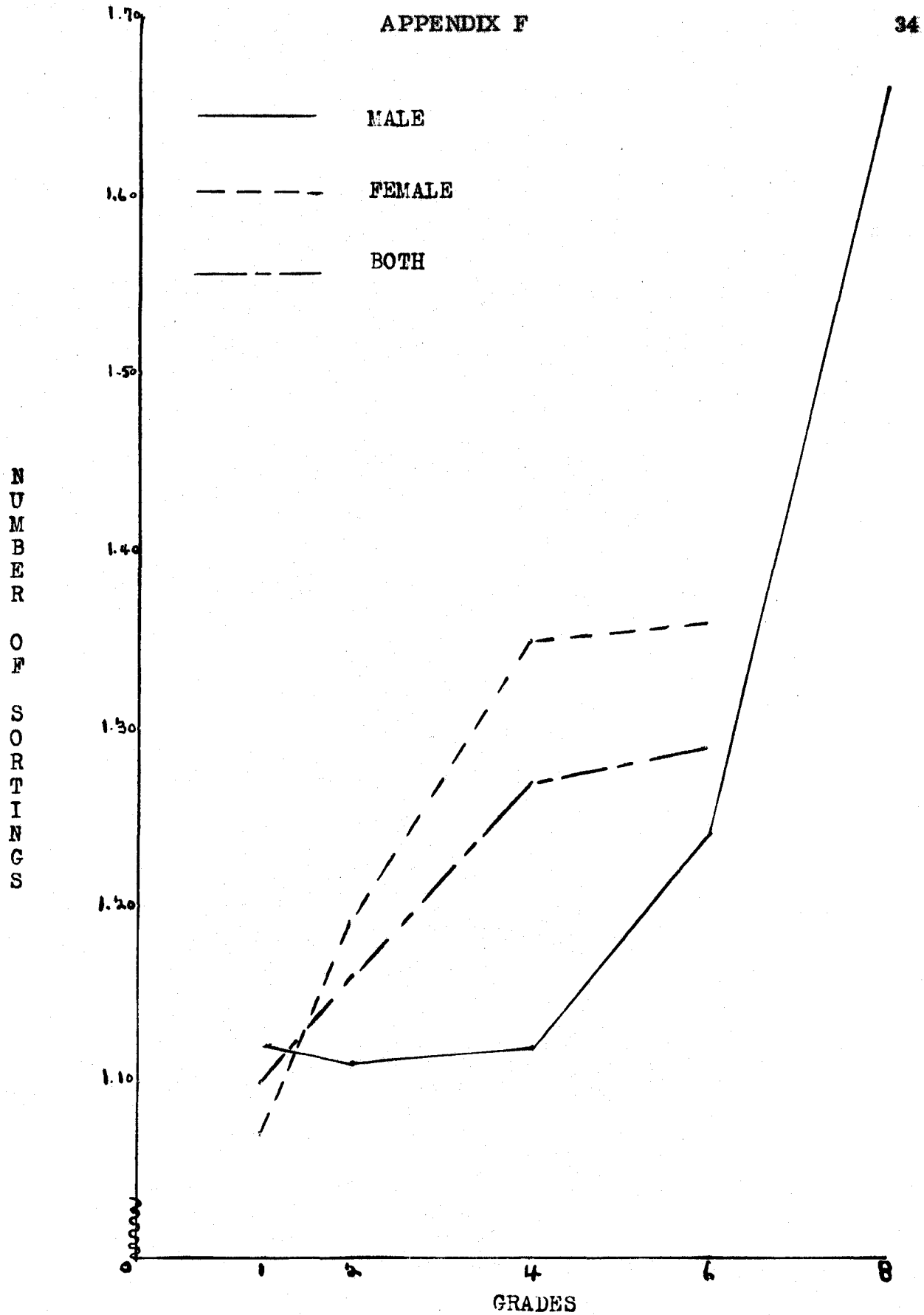
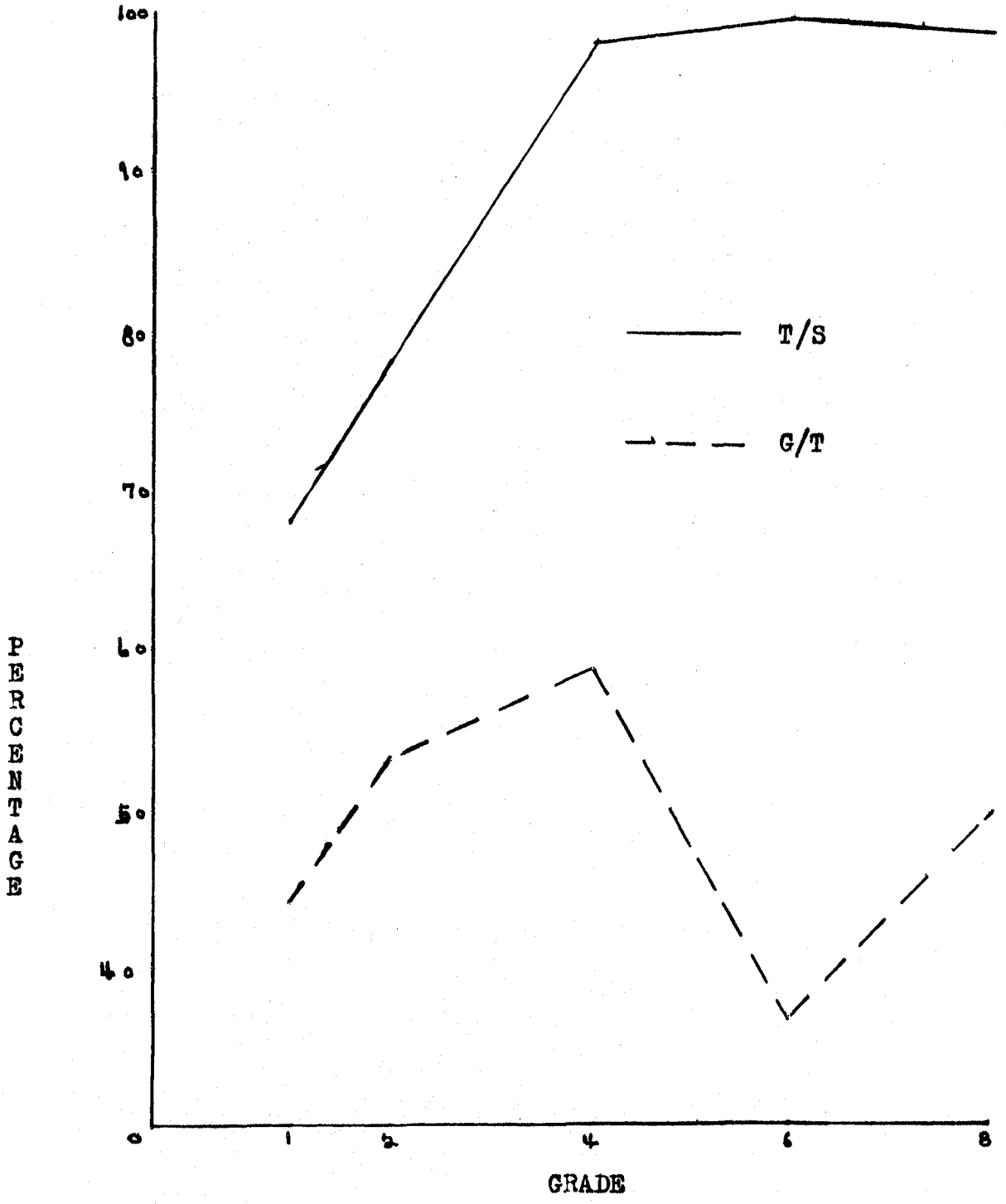


Fig. 6. Median number of sortings.



T/s -- Total naming to total sorting.

G/T -- General naming to total naming.

Fig. 7. Percentage of naming to sorting.

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