

A STUDY OF CONCEPT FORMATION IN CHILDREN¹

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I. INTRODUCTION

The term "concept" has been defined by McDonald as "a classification or systematic organization of stimuli."⁽⁶⁾ Therefore, a concept is not direct sensory data but derived from the elaboration and combination of sensory data. The common elements in discrete objects or situations serve to unite objects or situations into a concept. The attainment of certain concepts actually means that one has acquired some tools to understand his environment and some degree of mastery over it.

How does a concept develop? As described by Hull, "Concept formation is a process of generalizing abstraction which involves the discrimination of a particular element common to variety of stimuli."⁽³⁾ In this light, there are two important processes involved in learning a concept.

(I) A discrimination is required. That is, one must be able to distinguish the characteristics of a given object or situation from the others and to know the similarities and differences of them. For example, if the child knows what a circle is, he must be able to distinguish circles from squares, triangles or other forms. If he fails in doing so, we will doubt that he has the concept of roundness at all.

(II) A generalization is required. Generalization is a very complicated thinking process which involves recognition of the present stimulus-pattern and reflective thinking in order to relate the present stimulus-pattern with the old experiences. He must be able to utilize the knowledge formerly acquired to interpret new experiences. This indicates that one must not only have the abstracting ability to grasp the common elements from discrete experiences but also can use them as basis to categorize or to group objects.

How do children form basic concepts according to the above mentioned principles? What are the important characteristics of concept formation in children of different ages? These questions are my major interest of concern. Specifically speaking, the main purpose of this study is to use forms and colors as stimulus-patterns to find out the following characteristics:

- (I) The concept of forms and colors of children of different ages.
- (II) The discriminative ability of children of different ages.
- (III) The generalizing ability of children of different ages.
- (IV) The important characteristics of grouping behavior of children of different ages.

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II. PROCEDURE

(I) The Subject: 55 children are selected for this study. Among them, sixteen girls and twenty boys are kindergarten children. Six girls and thirteen boys are first and second graders of a public primary school. They are selected at random from the enrollment of the school year of 1965-1966. Their age-range is 23 months to 96 months. The age-mean is 63 months, and standard deviation (SD) 21 months. The subjects are grouped according to their chronological ages (CA). Children of two years are divided into two groups for the convenience of analysis. The IQ-range of the subject is from 59.7 to 161.1 with a mean of 98.1, and its SD of 22.54. The average duration of their attendance at kindergarten is around one year. The first and second graders, including the years of their attendance at kindergarten, have been in school for three to four years. The personal and family backgrounds of all subjects acquired from interview with the parents are presented in Tables I and II.

Table I. The Subjects Backgrounds

Number of Subjects	Sex		Age (Mons.)			IQ			Education		Ordinal Positions			
	M	F	Range	Mean	SD	Range	Mean	SD	Kinder- garten	1-2 Graders	Only Chil.	Old. Chil.	Mid. Chil.	Young- est Chil.
55	33	22	23-96	63	21	59.7- 161.1	98.1	22.54	36	19	10	14	14	17

Table II. The Subjects' Family Backgrounds

Parents' Education								Parents' Occupation				Socio- Economic Conditions
Father				Mother				Father		Mother		
College level	H. S. level	P. S. level	None	College level	H. S. level	P. S. level	None	Prof.	Non- Prof.	Working outside	House- wives	
35	15	3	2	16	29	7	2	43	11	25	29	Average
63.64 %	27.27	5.45	3.64	29.63	53.7	12.96	3.7	79.63	20.37	46.29	53.71	

(II) Materials: Five tests are used for this study. They are form discrimination test; color discrimination test; Goldstein-Scheerer color-form sorting test⁽²⁾; Gelb-Goldstein color sorting test⁽²⁾; and E. Hanfmann and K. Kasanin's concept formation test.⁽³⁾

(III) Procedure: The tests are given individually one at a time. The timing of the experiment is not arbitrarily scheduled due to the short attention span of young children. The criteria for passing all tests would be three correct responses made by the subject successively. If he fails to make correct responses in six continuous trials, the subject is considered having failed once. If three such failures are made by a subject successively, he is out of the test. But, he will have the chance to try on the next test. Running records of subjects' responses toward the tests are taken carefully and in great detail.

All the kindergarten children take Merrill-Palmer Scale, and the elementary school children take Binet-Simon Intelligence Scale. All the tests are given individually. The test scores of Merrill-Palmer Scale are translated into IQ scores for the convenience of analysis.

As the regular experiments and intelligence tests have been completed, the experimenter goes to visit subjects' families to interview their parents in order to get more information about the subjects and their family backgrounds.

III. RESULTS

The focus of attention in this study is directed toward a comparison between various age groups in terms of correct responses to the above mentioned five tests. The result will be discussed in the following:

(I) Test One

The number of cases and their percentages of Ss in each age group who have made correct responses on the form discrimination test, on naming the form and on giving correct verbal explanation for their choices, are shown in Table III.

The data reveals that the subjects' ability to discriminate different forms appears rather early. 50 per cent of subjects (Ss) at CA 2-2.5 can discriminate circles and triangles; 75 per cent of them can discriminate squares. None of them under CA 2 has made any correct response, and those above CA 2.5 find no difficulty in making correct responses to circles, squares, and triangles.

Table III also shows that Ss younger than CA 3 are unable to name the various forms correctly. Ss of CA 3 and 4 know circle better than square and triangle. Reaching age 5, Ss can name the circle, square, and triangle precisely.

Ss' ability to give correct verbal explanation for their choices begins to appear at CA 3, and this ability increases with age. Ss of CA 7 and above have made 100 per cent correct verbal explanation for their choices.

Most Ss at CA 2-6 take circle as their first preference rather than square and triangle. Ss at CA 7 take triangle as their choice. The order of their preference is triangle (44.44%), square (33.33%), and circle (22.22%).

(II) Test Two

The number of cases and their percentages of Ss in each age group who have made correct responses on the color discrimination test and succeeded in naming the color and giving correct verbal explanation for their choices, are shown in Table IV.

Table IV shows that 50 per cent of Ss under CA 2 are able to make correct responses to red, yellow, and blue colors. 50 per cent of Ss at CA 2-2.5 can discriminate red color. Only 25 per cent of them can discriminate yellow color but none of them can discriminate blue and green colors. Ss at CA 2.5-3 can discriminate red and yellow colors and only one third of them can discriminate blue and green colors. Up to CA 3 and above, Ss find no difficulty in discriminating red, yellow, blue, and green colors.

Table III. Number and percentage of Ss at each of 8 age groups making correct responses of form discrimination test

Items CA	Circle						Square						Triangle							
	Correct Naming		Cor. Verb. Explan.		First Preference		Correct Naming		Cor. Verb. Explan.		First Preference		Correct Response		Cor. Verb. Explan.		First Preference			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Under 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
2-2.5	2	50	0	0	3	75	0	0	0	0	0	0	2	50	0	0	0	0		
2.5-3	3	100	0	0	3	100	0	0	0	0	1	33.33	3	100	0	0	0	0		
3	8	100	7	87.5	4	50	5	62.5	8	100	4	50	1	12.5	2	25	1	12.5		
4	9	100	8	87.78	8	88.89	5	55.56	9	100	7	77.78	2	22.22	8	87.78	3	33.33	2	22.22
5	8	100	8	100	7	87.5	5	62.5	8	100	6	75	2	25	8	100	3	38.5	1	12.5
6	8	100	8	100	7	87.5	6	75	8	100	7	87.5	0	0	8	100	8	100	2	25
7	10	100	10	100	10	100	2	22.22	10	100	9	90	3	33.33	10	100	9	90	4	44.44

Table IV. Number and percentage of Ss at each of 8 age groups making correct responses on color discrimination test

Items CA	Red						Yellow						Blue						Green						
	Correct Naming		Cor. Verb. Explan.		First Preference		Correct Res-ponse		Cor. Verb. Explan.		First Preference		Correct Naming		Cor. Verb. Explan.		First Preference		Correct Res-ponse		Cor. Verb. Explan.		First Preference		
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N
Under 2	1	50	0	0	1	50	1	50	0	0	0	0	1	50	0	0	0	0	0	0	0	0	0	0	
2-2.5	2	50	0	0	3	75	1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.5-3	3	100	2	67.67	0	0	3	100	1	33.33	0	0	1	33.33	0	0	1	33.33	0	0	1	33.33	0	0	
3	8	100	4	50	3	37.5	8	100	7	87.5	2	25	2	25	8	100	3	37.5	2	25	8	100	5	62.5	
4	9	100	8	88.89	3	33.33	9	100	7	77.78	3	33.33	1	11.11	9	100	1	11.11	2	22.22	9	100	6	66.67	
5	8	100	7	87.5	4	50	8	100	5	62.5	4	50	3	37.5	8	100	6	75	1	12.5	8	100	7	87.5	
6	8	100	8	100	5	62.5	8	100	8	100	5	62.5	3	37.5	8	100	8	100	5	62.5	8	100	6	75	
7	10	100	10	100	10	100	10	100	10	100	10	100	3	30.10	10	100	9	90	10	100	9	90	8	80	

Table IV also shows that the earliest age for giving correct names of various colors is at CA 2-2.5. The age of mastery over it is at CA 6. The Ss' earliest age for giving correct verbal explanation for their choices is at CA 3. The age of mastery over it is at CA 7.

Table IV reveals that there is a clear tendency in younger Ss toward taking red color as their first preference. 50 per cent of Ss at CA 2, 75 per cent at CA 2-2.5, 66.67 per cent at CA 2.5-3 are inclined to red color. After CA 3, along with growth, the preference for red color decreases continually. Up to CA 7, there is only 20 per cent of Ss who prefer red color. Percentages of first preference scatter around for the rest of the colors. No specific preference is shown.

(III) Test Three

Table V shows the results of Test Three made by Ss. In this test, each S has taken three trials. The frequencies of correct responses made by Ss either according to forms or to colors are counted and their percentages are calculated. Table V reveals that Ss younger than CA 2 are unable to make correct responses. These results indicate that before CA 2, Ss can hardly abstract a common element out of the various discrete objects.

Table V. Number and percentage of correct responses made by Ss at each of 8 age groups on color-form sorting test

Items CA	Color				Form				Failure	
	Correct Responses		Correct Verb. Explanation		Correct Responses		Correct Verb. Explanation		N	%
	N	%	N	%	N	%	N	%		
Under 2	0		0				0		6	100
2-2.5	1	8.33	0		2	16.66	0		9	75
2.5-3	3	33.33	0		5	55.56	0		1	11.11
3	10	41.67	0		14	58.33	3	21.43		
4	17	62.96	9	52.94	10	37.04	6	60		
5	12	50	7	58.33	12	50	8	66.67		
6	6	25	6	100	15	62.5	15	100		
7	2	6.66	2	100	28	93.33	28	100		

In comparing the percentages of correct responses in grouping the stimulus blocks according to forms and to colors made by Ss of each age group, we find a clear tendency that Ss at CA 2 and 3 are apt to group them according to forms. After CA 3, the percentage of groupings according to forms decreases while the percentage to colors increases. At CA 4, Ss seem more likely to group the stimulus blocks according to colors. From then on, the tendency of grouping according to colors decreases steadily. The dominant reaction pattern is shifting back to forms again at CA 5. 62.5 per cent and 93.33 per cent of the groupings made by Ss at CA 6 and 7 are according to forms. (Figure 1) The four failures appeared at CA 6

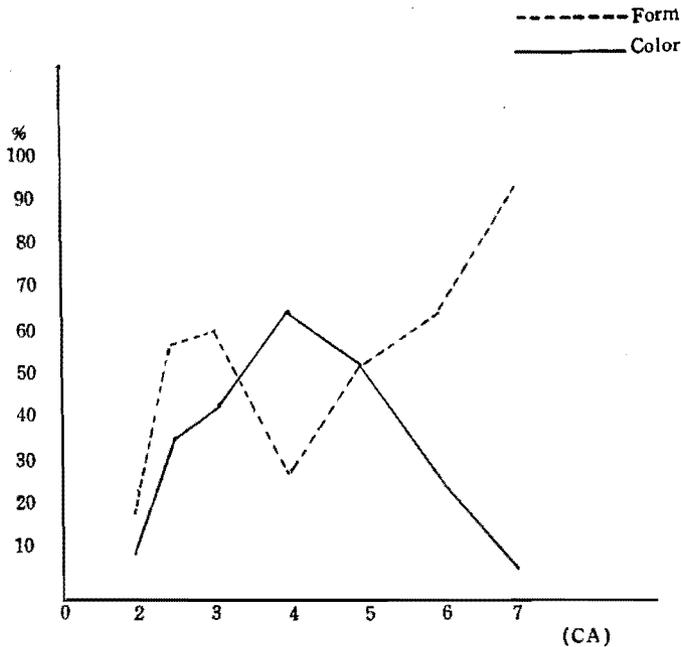


Fig. 1. The percentages of correct groupings according to forms and to colors by Ss in each age group.

may be due either to the misunderstanding about the statement made by the experimenter or the nervousness of the subjects during the experiment.

As far as the verbal explanation for their groupings is concerned, Ss at CA 2 are unable to give any correct responses. This ability is shown at CA 3 only for forms. The percentage is 21.43. The percentages of correct responses of Ss at CA 4 and 5 are 52.94 and 58.33 for colors, and 60 and 66.67 for forms. From CA 6 on, Ss find no difficulty in giving verbal explanation for their groupings both for forms and colors.

(IV) Test Four

The results of Test Four are analyzed by counting the total number of groupings made by Ss of each age group. Their grouping behavior can be classified into two categories: the concrete and the abstract approach. By using the concrete approach, the subject tends to do the matching for identical color skeins instead of classifying the skeins into four color groups (the color of red, yellow, blue, and green). The matching procedure has a certain range which depends upon the degree of concreteness. The Ss' grouping is analyzed according to the extreme degree of concreteness—matching for identical color skeins—and the lesser degree of concreteness. The latter means that the Ss' grouping involves more than identical color skeins but the number of them is fewer than that of the grouping which is considered as formulating conceptual thinking.

The abstract approach means that the S consciously treats the skein as a representative of a certain basic color hue. Although he knows the specified attributes

of an individual skein such as intensity, brightness and purity, he is able to ignore these differences and group them together according to a color concept. When asked the reason why he considers those skeins as belonging together, he is able to name the color category to back up his choice.

Table VI gives us a general idea how Ss respond to Test Four. It reveals that the average grouping made by Ss of each age group is more than four groups. The maximum reaches up to 10 at CA 4. The average grouping decreases slightly along with age but there is another increase beginning at CA 6. Ss under CA 2.5 are unable to make any correct grouping. Their average grouping is from 1 to 1.75. This indicates that they just make one mixed group by putting all different color skeins with various brightnesses into one group. A great amount of apprehension is shown.

Table VI. Average number and range of groupings, number and percentage of Ss, at each of 8 age groups according to concrete and abstract approach on color sorting test

Items CA	Number of Grouping		Concrete Approach						Abstract Approach			
			Extreme Degree of Concreteness			Lesser Degree of Concreteness			Red	Yellow	Green	Blue
	Average	Range	Subjects		Groupings	Subjects		Groupings	N	N	N	N
			N	%		N	%					
Under 2	1	1	0		0	0		0				
2-2.5	1.75	1-4	0		0	1	25	4				
2.5-3	6	1-13	1	33.3	13	1	33.3	4				
3	8.13	1-19	6	75	39	4	40	17	1	1		
4	10.44	7-14	8	100	52	8	100	36				1
5	5.88	4-9	4	44.44	9	5	55.56	24	2	2	2	2
6	8	4-12	4	50	22	3	37.5	13	2	2	3	3
7	10.1	4-12	7	70	63	2	20	14	3	3	3	3

Generally speaking, the dominant reaction pattern made by Ss toward Test Four is concrete approach. Matching for both extreme degree and lesser degree of concreteness has appeared in each age group above CA 2.5. The percentages of Ss who have matched for identical color are 33.33 at CA 2.5-3, 75 at CA 3, 100 at CA 4, 44.44 at CA 5, 50 at CA 6 and 75 at CA 7. The percentages of Ss of each age group who have matched for lesser degree of concreteness are 33.33, 50, 100, 55.56, 37.5 and 20 respectively. In comparing the percentages of Ss who have matched for identical color with those who have matched for lesser degree of concreteness, we find that Ss in each age group are inclined to match for identical color. This means that they take the extreme degree of concrete approach as the basis of their grouping.

There are only a few Ss who have shown the tendency of taking the abstract approach in their groupings. The S in this study who first showed this attitude is a girl of three years and ten months of age. She is able to group all skeins with different shades and brightnesses in red and yellow according to the color concept but has failed to do the same in blue and green colors. She can even tell the experimenter the correct verbal explanation for her choices. Of the 55 Ss, there are only 10 Ss who can produce groupings according to the abstract approach, one at CA 3, one at CA 4, two at CA 5, three at each of CA 6 and 7.

(V) Test Five

The concept formation test used for this study is a rather complicated one which requires not only discriminative ability, ability of sorting blocks according to their common characteristics, but also ability of making generalizations according to old experiences. Careful observation is made, and errors made by Ss for each of the Lag, Mur, Bik and Cev categories are counted. The average frequency and range of errors made by Ss of each age group are presented in Table VII.

Table VII. Average and range of errors made by Ss at each of 8 age groups on concept formation test

CA	Lag				Mur				Bik				Cev			
	Freq. of Errors		Failure		Freq. of Errors		Failure		Freq. of Errors		Failure		Freq. of Errors		Failure	
	Average	Range	N	%	Average	Range	N	%	Average	Range	N	%	Average	Range	N	%
Under 2			2	100			2	100			2	100			2	100
2-2.5	15	6-24	2	50	8	8	3	75			4	100			4	100
2.5-3	12	11-12	1	33	7	7	2	67	15	15	2	67			3	100
3	18	2-47	3	37.5	21.8	0-38	2	25	22.8	15-38	3	37.5	14.7	6-40	2	25
4	16.8	2-27			17.3	0-38			21	2-50			14.9	0-30		
5	8	0-22			13.3	0-31			14	1-44			11.4	0-23		
6	13.3	1-27			13	11-16	1	12.5	12.7	1-28			4	0-14		
7	4.1	0-8			3.1	0-18			2.1	0-14			1	0-9		

Table VII shows that Ss under CA 2 are not able to handle the task comprehensively. Their typical reaction is just grasping the blocks in hand to play or refusing to act accordingly. All of them fail to carry out the performances.

Observing the average and range of errors made by Ss at CA from 2 through 6 for each of the Lag, Mur, Bik, and Cev categories, we can understand that Ss' grouping processes are completely based on trial and error behavior. No insight whatsoever is evidenced. Accidentally, some Ss at CA 4 and 5 have found that there are certain marks on the bottom of the blocks. They start to look for the marks and use them as the basis for their groupings. However, they can not understand there is a meaningful connection between the mark and the blocks.

Insight and generalizing ability are first shown at CA 7. This is exhibited by a remarkable decrease of errors made by Ss for each of the Lag, Mur, Bik, and Cev categories. This indicates that Ss younger than CA 7 are unable to grasp the meaning of the task of classification. They have no insight into the multiple possibilities of grouping the blocks but try to match them either according to colors or to forms. They can never actively apply definite categories to the material but are rather passively led by vaguely perceived similarities of the blocks which may become related to one another as individuals. This tendency is justified by Ss' verbal explanations which indicate that they can only grasp partially the characteristics of the blocks. Their answers are either large or tall, small or flat, but never combine both together.

IV. CONCLUSION AND DISCUSSION

The results of this study provide us with some understanding about the nature of the process of form and color concept formation in children of different ages. Judging from the data shown in tables III, IV, V, VI and VII, we know that Ss under CA 2 can hardly make any correct responses toward the five tests used in this study. It seems that the third year of life is an important period at which children start to construct the outside world according to their common elements.

The Ss' discriminative abilities for forms and colors appear in a parallel fashion at two years of age. But, their abilities to discriminate various forms or colors do not appear at the same time. This study shows that a single form or color is named correctly while other forms or colors are still confused. Ss under three predominantly use form in preference to color as the basis for sorting the blocks. Between the age of three and five there is a gradual shift to color; but after five form becomes dominant again.

Both form and color matching antedate form and color naming which in turn appears prior to giving correct verbal explanations for their choices. This fact indicates that Ss' grouping behavior is from perceptual to conceptual level. The basis of grouping for Ss younger than CA 3 is solely dependent upon the sensory cohesiveness of impression. This is only a primitive and lower level of discrimination. At CA 3 and above, the Ss can name the color or the form correctly. Therefore, we may consider them as having got the meaningful understanding of the form or color and having acquired the concept of it. In this light, we can conclude that Ss' ability to make generalizations first appears at CA 3. From then on, there is a steady increase in their ability to group objects together and to give abstract and conceptual explanations of the groupings.

According to the data of Tables VI and VII, most Ss in this study have taken the concrete attitude in grouping and sorting things. That means Ss tend to do the matching for the identical color instead of classifying the skeins into four color categories (red, yellow, blue, and green). Their matching for the identical color

skeins or forms is due to their treating the stimulus-pattern as a thing and not as a representative of a certain category. The bases of their groupings are completely dependent upon the perceptible characteristics of the stimulus-pattern. This fact is an expression of Ss' lack of a general reference and experiences. This tendency has also reflected itself in their reaction patterns of hesitancy, in calling skeins of various shades of one color by different names, and in making pseudo series. Pseudo series means that some Ss can produce a grouping which includes quite a large number of skeins belonging to a certain basic color concept. But, when the experimenter asks the reason why those skeins belong together, the subject will claim that the skeins which he has formerly grouped together are not the same. Usually, he would rearrange them according to the identical color or would give them different names. We, therefore, understand that the subject has no such categorical point of view in mind nor does he have the intention of forming a series according to a color concept.

Data shown in Table VII will give us a more clear-cut picture about the fact that the Ss younger than CA 7 are unable to assume the conceptual or the abstract attitude to the task. These results will support the findings of Test Four. Compliances with the grouping or sorting tasks of Tests Four and Five definitely requires three most important abilities. They are the categorical attitude, the insight into the multiple possibilities of choice, and the consideration of the whole. The categorical attitude embraces more than the real stimulus in its scope. It consists, in our setting, of viewing the stimulus-pattern not as individuals but as bearers of certain general characteristics and as representatives of a certain category. The majority of Ss in this study lack this attitude. Consequently, Ss are limited to the perceptible characteristics of the stimulus-pattern. This is the reason why in Test Four, they group the identical color skeins together and in Test Five, they find no way to group the blocks together except turning them up to read the marks according to which the groupings are made. The second aspect, closely related to the first one, is the insight into the multiple possibilities of the choice. This ability is especially required of Ss in order to perform Test Five correctly. A subject who lacks this insight may be able to organize the blocks according to some characteristics which are fundamental to him. He may, for instance, see the blocks as squares, circles and triangles, or as red, yellow, white and other colors. He is not able to realize that this is only one of the possible ways of seeing them. As a result, he would not be able to find any other characteristics. The third aspect is the consideration of the total system of the stimulus-pattern. This ability will give Ss more freedom to see the relationships among the blocks and to react more flexibly.

These characteristics are not evidenced in the behavior of most Ss younger than 6 and 7 years old.

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兒童概念的形成

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摘 要

一、目 的：

本研究之目的，在觀察幼稚園與小學初年級兒童，對於形狀與顏色之認識與了解，同時亦觀察各年齡兒童如何根據測驗積木之共同特徵予以分類，以及他們在上項分類行為上所表現之種種特色。

二、歷 程：

1. 對象：本研究係以55名兩歲至八歲之兒童為研究對象，其中36名是幼稚園與托兒所兒童，19名是小學一、二年級學生。
2. 方法：每位受試者均個別施予下列五種測驗。(1)形狀辨識測驗，(2)顏色辨識測驗，(3)顏色形狀分類測驗，(4)顏色分類測驗，(5)概念形成測驗，並舉行智力測驗及家庭訪問。

三、結 果：

1. 在本研究中顯示。幼小受試者辨別形狀與顏色之能力發生在先，認識形狀與顏色之名稱在後。對於各種形狀與各種顏色之辨識能力並非同時出現。兩歲至兩歲半之受試者多能辨識圓形，方形，紅色以及黃色，而對三角形與藍綠二色則辨識力較差，至五歲後，全部受試者都能辨識圓形，方形及三角形。至六歲後始全能辨識紅，黃，藍，綠四色。
2. 本研究顯示，三歲前之受試者多喜紅色，三歲後對紅，黃二色喜愛之程度較優於藍綠二色。形狀方面，七歲前之受試者多喜圓形，七歲後對圓形，方形，三角形喜愛之程度無顯著之差異。
3. 本研究顯示，自兩歲開始，受試者能夠將測驗中之積木按其共同特徵分成類別。三歲之後始能表現概括能力，即利用舊經驗來解釋目前事物之能力。兩歲至三歲之受試者多以積木之形狀為分類標準，三歲至五歲之受試者多以積木之顏色為分類標準，五歲之後又再傾向以形狀為分類標準。
4. 本研究顯示，大部分之受試者均以積木之具體的，能知覺的特徵為分類標準，他們只能知覺積木之部分特徵，不能於分類時考慮多種因素，缺乏將物體予以抽象化之能力，因此只能將完全一樣之顏色歸於一類，不能同時考慮顏色之深淺程度。唯內有極少數三歲後之受試者，能將同一性質而深淺程度不同之顏色歸於一類。