The PSYCHOLOGY OF DRAWING

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The Psychology of Drawing

With Special Reference to Laboratory Teaching

BY

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PREFACE

This book represents the results of a study of drawing as a device in laboratory teaching which has included a survey of the existing literature of the psychology of drawing. An attempt has been made to characterize the chief contributions to the psychology of drawing and to organize the results of the important studies in such a manner as to afford students of the various aesthetic, economic, and scientific aspects of drawing a scientific point of departure.

It is with great pleasure that I indicate here my sincere appreciation for the assistance which I have received from teachers, friends, and students. Among many deserving ones I wish to mention in particular the names of Dr. Otis W. Caldwell, Professor of the Teaching of Botany; Walter Sargent, Professor of Education in Relation to Fine and Industrial Arts; and Dr. Charles H. Judd, Professor and Director of the School of Education of the University of Chicago. Professor Caldwell has given me great practical assistance in the setting and investigation of the laboratory prob-

lem involved and has been of unfailing help and encouragement throughout the study. I am a heavy debtor to Professor Sargent for numerous critical suggestions in the analysis of drawing and hearty co-operation in a number of experiments. Especial acknowledgment is cheerfully rendered to Professor Judd whose keen criticism of the content and form of this production has removed many errors and contributed greatly to its merit.

FRED CARLETON AYER.

University of Oregon,
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CONTENTS

PART I. THE SCOPE OF THE PROBLEM

PART II. SURVEY OF THE LITERATURE OF DRAWING.

PART I

THE SCOPE OF THE PROBLEM

THE PSYCHOLOGY OF DRAWING WITH SPECIAL REFERENCE TO LABORATORY TEACHING

CHAPTER I

THE PROBLEM

I. Introduction.

The laboratory method has come to be practically universal in the teaching of science. The process of drawing is everywhere esteemed as a most significant form of laboratory methodology. To some degree in the physical sciences, but more especially in the biological sciences, the amount of time devoted to making pen and pencil drawings is a major part of the laboratory procedure. Many pupils encounter great difficulty in making the required drawings. They either make poor drawings or consume a disproportionate amount of time in the effort to make good ones. Because of this, many receive low grades, are discouraged, and discontinue their work in the field of science. The widespread use of a teaching device which consumes extended periods of time in all cases, and fails to meet the needs of individual pupils in many cases, raises an important problem.

II. The General and Specific Problems.

Laboratory work brings the pupil into first-hand contact with the objective material with which its particular science is concerned. The chief end of laboratory work is to insure a better understanding and a more permanent retention of the material concerned. Omitting personal demonstration and instruction, laboratory procedure involves the following factors:

1. Analytical Observation. The pupil is given oral or written directions of procedure which aim to direct his attention to the material in such a way that he will master it. Three special devices are used to promote analytical observation.

(a) *Representative Drawing.* The student is asked to reproduce the object in an imitative drawing. "Lay the locust on its back. Make a careful drawing, lateral view."

(b) *Description.* The student is asked to describe what he observes. "What is the shape of the head?"

(c) *Analytical Drawing.* The pupil is asked to explain in a schematic drawing some particular aspect of the object. "Make a diagrammatic drawing of the lily, showing the relative position of the pistil, stamens, petals, and sepals."

2. Laboratory Records. A second factor of laboratory procedure is the laboratory record.

The pupil is asked to keep a graphic record of his work which permits his instructor to measure his progress. The record consists of one or more of the following graphic products:

(a) Representative drawings.
(b) Descriptions.
(c) Analytical drawings.

3. Retention. A third factor of laboratory procedure is concerned with subsequent recall. The results of laboratory work are fixed in memory according to the success of the analytical observation and the reinforcement given by the making of records.

In a word, laboratory work has three aims: the observation of material, the making of records, and the retention of learning. It furthers these aims by three devices: representative drawing, description, and analytical drawing. Our general problem is *to determine the character of the various interrelations of the factors which enter into laboratory procedure.*

Current practice varies as to the method of securing analytical observation and recording results. Most instructors give as few specific directions as practicable so that the student may exercise the maximum of initiative. The process of descriptive explanation or that of drawing is supposed to focus the attention upon the salient characteristics of the object or organism. Many

teachers, as we shall show presently, believe that this is one of the particular values of representative drawing. Similarly, in the recording of results, description and drawing are used more or less interchangeably, varying according to the laboratory manual used. Drawing almost always has an important place in the records and in some cases is used exclusively. Our special problem is *the psychological analysis of laboratory drawing.*

Does drawing secure analytical observation? Is drawing a reliable record of the pupil's work? Does drawing promote the most desirable retention? If the process of drawing fails in any or all of these respects, it follows directly that a very conspicuous amount of present-day laboratory methodology is founded upon fallacious principles and is in need of radical readjustment. That such is the case is the conclusion of this thesis, and it is hoped that the facts emphasized by the analysis of previous investigations and the results of the present experiments will lead to a better understanding of the psychological principles involved in drawing as well as materially improve present-day methods of laboratory teaching.

III. Definitions.

At this point it will be well to define several terms which appear frequently in the pages to follow. An early understanding of these expres-

sions will aid materially in following the thread of the succeeding discourse.

1. Analytical Observation. Every material object or process has a number of characteristics which may be grasped in consciousness with sufficient clearness to afford a basis for comparison and analysis. A locust's hind legs are longer than his fore legs; a pendulum swings repeatedly in the same period of time. Certain characteristics, such as the lengths of the locust's legs, are noticed because of difference; other characteristics, such as the successive swings of the pendulum, are compared on the basis of similarity. In either case the observer notices the separate items as such first and makes the comparison afterward. "The perception of sequence aids us in the perception of difference."

What an individual sees in an object depends upon the knowledge he brings to it. But it is important to note that it depends upon much more than that. The detail of observation is determined by its immediate purpose. If we study an insect with the preconceived purpose of painting it, immediately we begin to compare items of color and form. The entire analysis is concerned with these things and no other. On the other hand, if we approach the insect with the preconceived purpose of discovering how injurious it may be to the crops, at once we attend

to the comparative structure of the insect's mouth-parts, its egg-laying apparatus, or similar anatomical features. It is obvious that the items of analysis must be related to the problem of the particular moment. This is a matter of great pedagogical importance to laboratory teaching, because there are innumerable characteristics attaching to any object or process which are not of scientific importance. The analysis must involve scientific comparisons and not those of aesthetic, moral, or other interest.

Our particular interest, then, in "analytical observation" is the interest of science, and as such we shall use the expression herein. The method of its attainment is one of our major problems.

2. *Representative Drawing.* A drawing is "representative" which reproduces as accurately as possible the exact appearance of an object. The product is a visual imitation of the original. Representative drawing may refer either to the process or to the product.

3. *Analytical Drawing.* When imitation is not the chief end, representation in drawing may be modified in various ways. This begins with the omission of certain details of surface appearance. A drawing of a chair does not show the grain of the wood. Omission continues until the mere outline of the object completes the representation.

Whatever is shown is emphasized at the expense of the characteristics left out.

The actual appearance of the object is altered in a second type of modification. This is well shown in the illustrations of our elementary physiologies, where the structures are greatly simplified in the drawings, as, for example, the cross section of the thorax.

A third type transcends the limits of perspective and opacity. The drawing shows more than the eye can actually see. The same drawing, for example, shows the shoe, the foot, and the bones of the foot. This is sometimes called logical realism as distinguished from the visual realism of representative drawing.

A fourth modification of the representative drawing is the type or symbolic drawing. This drawing portrays the characteristic features only, which a number of objects have in common. It is generic rather than specific. The type drawing of a bird, for example, is not an imitation of an actual bird, but exhibits such features as feathers, beak, wings, etc., which all birds have in common. The perfect type drawing shows all of the common features of the group represented. As its symbolism becomes more and more pronounced, it loses in visual representation until but one pronounced characteristic may mark the type, as when a single feather stands for *bird*.

It must not be supposed that these four primary modifications of drawing are entirely distinct from one another. As a matter of fact, they are closely interrelated. In practice the schematic drawing is ordinarily a blend of two or more of the typical modifications. But whatever the form of the modified drawing, a preliminary comparison and analysis of the characteristics which are to be emphasized in the drawing is necessary. The analysis may result in no more than the simple diagram of the hand, or it may lead to the synthesis necessary to construct a drawing which shows the basic floral plan of the entire rose family. In any case the resultant drawing is an indication of preliminary analysis and gives rise to the name "analytical drawing," which we have chosen and will use in this sense.

4. Memory Drawing. This expression refers to drawings of objects or scenes from the memory of one or more previous views.

5. Spontaneous Drawing. A drawing which is made voluntarily by a child from memory or the imagination without previous suggestion of a subject.

6. Schema. This term refers to any typical drawing which is used repeatedly to represent the same class of objects. A circle, for example, with two straight lines attached below is frequently the child's first "schema" for a man. At the

other end of the scale is the mass of detailed schemata which the professional drawer ordinarily has at his command, enabling him to make an instant memory drawing of practically any common form.

IV. General Procedure.

My attention was called to the problem involved in the use of drawings for analytical and representative purposes while directing the laboratory drawing of various students in biology classes. The frequently observed variations in drawing ability among students otherwise similarly gifted, and the difficulties with drawing experienced by certain pupils who were excellent in grasping scientific principles, led me to set the definite problem of measuring the correlation between drawing and the study of science. In this I have utilized the following general procedure. (For details and results of these tests, see later chapters.)

1. *Correlation.* Four groups of subjects were carefully tested with unfamiliar objects as to their abilities in drawing, description, and diagramming. The members of each group were then ranked serially in the order of the merit of their productions by a group of judges. The amount of correlation existing between any two abilities, such as drawing and description, was then established by the use of a correlation formula. The four groups of subjects follow.

(a) 51 high school students of the University of Chicago High School, examined in 1912.

(b) 48 graduate students in the School of Education, University of Chicago, examined in 1912.

(c) 50 college students of the University of Oregon, examined in 1913.

(d) 61 college students of the University of Oregon, examined in 1913.

2. Memory Tests. After the students in groups (a), (c), and (d), above, had drawn and described various objects, they were examined as to their memory of the various details. Comparison between the effects of the two processes was then made, either by the process of serial correlation or on a percentage-of-error basis.

3. Introspection. Immediately after drawing and describing an object, group (b), above, made an introspective analysis of the two processes involved. This has been supplemented by numerous tests of individuals of a similar nature since 1912.

4. General and Special Ability. In 1913 I made an investigation of the correlation between ability in drawing and aptitude in other school subjects on the basis of school grades. In this I compared the grades of the 51 University High School students with their ranking in drawing as discovered in the special tests. In addition I compared the

grades received in drawing by 141 normal school students with the grades received in all other subjects.

5. The Effect of Analytical Seeing upon Drawing. In 1912 I made an experimental study with 16 subjects who were students in the University of Chicago School of Education. Eight of the subjects were directed to consider the comparison between the size of the beak and of the foot of a bird. The other eight were directed to study the details of the bird's foot. The entire group was then directed to make an accurate representative drawing of the bird, which was placed in full view of all. Comparative measurements were then made of the individual drawings.

In addition to these original tests I have had children of various ages and a number of adults make drawings to exemplify the results of a number of the experiments listed in the following survey.

PART II

SURVEY OF THE LITERATURE OF DRAWING

Chapter II

THE METHODS OF RESEARCH AND BIBLIOGRAPHICAL SURVEY

The methods of research which have been employed in the analysis of the activity and results of drawing may be divided into two general groups—the objective and the subjective. The *objective* methods are typical of investigations which have been chiefly concerned with the study of the *products* of drawing. The *subjective* methods are typical of the researches which have inquired more specifically into the mental or formal phenomena which accompany the *process* of drawing. It is profitable for purposes of analysis to subdivide the objective and subjective methods into a number of subordinate types which are characteristic of the various studies of the psychology of drawing up to the present time.

Objective Methods

1. *Gross Products Method.* In which the investigation has to do with relatively indiscriminate collection of large numbers of drawings.

2. *Special Products Method.* In which the study is concerned with the collection of drawings related to some specific theme, such as the illustrations of a given story.

3. Comparative Products Method. In which the drawings of one typical group of individuals are compared to the drawings of a second, as the drawings of children with those of savages.

Subjective Methods

4. Biographical Method. In which drawings of the same individuals are collected in a series covering an extended period of time and accompanied by records of the subjective behavior.

5. Experimental Method. In which the act or process of drawing is analyzed by a relatively definitely controlled experiment.

The five types of research indicated above will be treated in greater detail in the following summary of methods and related bibliography.

I. The Gross Products Method.[1]

This method involves the gathering of a great mass of objective material in the way of drawings collected by parents or teachers who are not familiar with accurate psychological procedure. The drawings are analyzed with reference to whatever common facts may appear. The gross products method has a serious disadvantage in

[1] Compare "die statistische Methode" of Ruttmann (87) and "la methode de collectionnement" of Rouma (86). (Figures in parentheses refer to the number of the citation as listed in the bibliography at the close of this work.)

that the more essential conditions and circumstances attendant upon the individual drawing are not known to the interpreter of the accumulated results. This results in generalizations upon seeming similarities which are in reality due to different causes. There are also dangers due to the effects of influence unknown to the collector, such as advice from the parent or imitation of other drawings.

Investigations of this type were very popular in the United States during the last decade of the nineteenth century and, while open to criticism, have paved the way for more accurate conclusions as the conditions of the drawing have been determined with greater precision.

From the historical point of view, one of the most important studies of this type is that made by Carrado Ricci[1] of Bologne, Italy. His work created widespread interest in children's drawings and has been widely quoted by subsequent writers. Ricci's material included 100 drawings by children of his friends, 1000 drawings made in the common schools of Bologne, and 250 drawings from the schools of Modene, together with the modelings in clay by 20 children. Ricci's work discusses a number of phases of drawing which have been studied in detail by subsequent investi-

[1] Ricci, L'Art dei Bambini, 1887. (See bibliography for complete titles.)

gators, such as stages in the evolution of drawing, the child's sense of beauty, the development of the sense of color, and the art of primitive races.

Other studies of this type are those of Hall[1], O'Shea,[2] Maitland,[3] Lukens,[4] and Barnes.[5] Hall interpreted a number of drawings of children as indicative of their early thinking. O'Shea made a study of the drawings of a number of Wisconsin school children from 5 to 17 years of age. Mrs. Maitland made an analysis of 1570 drawings of California children from 5 to 17 years. Lukens studied the drawings of 1232 attempts at representation by children under 10 years. Barnes interpreted 700 papers by girls in London Board Schools writing under the direction: "Describe the prettiest thing you have ever seen, and say why you thought it pretty."

II. The Special Products Method.[6]

With the establishment of more definite conditions as to the incentive for drawing and the com-

[1] Hall, Contents of Children's Minds on Entering School, 1892.

[2] O'Shea, Children's Expression through Drawing, 1894.

[3] Maitland, What Children Draw to Please Themselves, 1895.

[4] Lukens, A Study of Children's Drawings in the Early Years, 1896.

[5] Barnes, The Prettiest Thing, 1902.

[6] Compare "die monographische Methode" of Ruttmann and "la methode des enquêtes" of Rouma.

position of the group of drawers, the gross products method passes over into the special products method. The incentive for drawing may vary according to the interest of the investigator, but it always centers in a definite problem. For instance, a group of children is asked to illustrate a story which has just been read to them, to draw a picture of a house from memory, or to represent some object presented directly to them. The homogeneity of the group is definitely restricted in age, training, sex, race, etc., according to the purpose of the study. The products obtained permit the analysis of the perceptual and presentation side of drawing to a certain degree, but the emphasis is laid upon the product itself. It is not essential that the investigator be present or that a record be kept of the accompanying subjective phenomena.

The majority of existing researches have utilized this method in whole or in part, and a wealth of material has been collected. The chief center of activity in this field for the past decade has been on continental Europe, although such early American works as those of Barnes are of importance in this field.

The work of Earl Barnes[1] is one of the earliest attempts to interpret large numbers of children's drawings secured upon this basis. Barnes made

[1] Barnes, A Study of Children's Drawings, 1893.

use of an English version of the poem *Hans Guck-In-Die-Luft*, taken from *Der Struwwelpeter*. The poem was first read to the children; they were then told that they were to draw one or more pictures from the story. The story was read the second time and the children proceeded to draw. The poem follows:

JOHNNY HEAD-IN-THE-AIR

As he trudged along to school,
It was always Johnny's rule
To be looking at the sky
And the clouds that floated by;
But just what before him lay,
In his way,
Johnny never thought about;
So that everyone cried out:
"Look at little Johnny there,
Little Johnny Look-In-The-Air."

Running just in Johnny's way,
Came a little dog one day;
Johnny's eyes were still astray
Up on high, in the sky;
And he never heard them cry:
"Johnny, mind the dog is nigh!"
What happens now?
Down they fell with such a thump,
Dog and Johnny in a lump!
They almost broke their bones,
So hard they tumbled on the stones.

Once with head as high as ever,
Johnny walked beside the river.
Johnny watched the swallows trying
Which was cleverest at flying. . .
Going in and coming out—
This was all he thought about,
So he strode on—only think!—
To the river's very brink,
Where the bank was high and steep,
And the water very deep;
And the fishes in a row,
Stared to see him coming so.

One step more! Oh, sad to tell!
Headlong in poor Johnny fell.
The three little fishes in dismay,
Wagg'd their heads and swam away.
There lay Johnny on his face,
With his nice red writing-case;
But, as they were passing by,
Two strong men had heard him cry;
And, with sticks, these two strong men
Hook'd poor Johnny out again.
Oh! you should have seen him shiver
When they pulled him from the river.
He was in a sorry plight,
Dripping wet, and such a fright!

This poem presents two catastrophes and, in all, nine scenes for illustration. The aim of the research was to determine what scenes were most often drawn; at what ages the greatest number of pictures were drawn; differences between boys and girls; and the laws governing the use of full face and profile. In all, Barnes collected 6393 papers (chiefly from California), including 15,218 pictures from children about equally distributed among the ages 8 to 16. S. Partridge in England, and Levinstein and Lamprecht in Germany, have used this same story and sheet of instructions.

Clark[1] made use of some 700 drawings of children in a study of their difficulties with perspective. The first group of drawings collected were the products of the attempts of children to draw an apple with a hat pin stuck horizontally through it and turned at an angle to the observer. A second group consisted of the representations of a book lying side down and turned at an angle to the observer.

Lena Partridge[2] has classified the drawings of men and women by 2000 English children from 3 to 13 years of age. Her analysis of the graphic products is made for various ages on the basis of (1) presence of certain parts of the human

[1] Clark, The Child's Attitude toward Perspective Problems, 1897.

[2] Lena Partridge, Children's Drawings of Men and Women, 1900.

figure, (2) mode of representation of parts, (3) direction and inclination of parts, (4) attention given to clothes, and (5) sex differences.

Miss Findley[1] investigated the special problem of the presence of artistic taste among children.

Among the studies made in France, Belgium, and Switzerland may be mentioned those of Passy, Perez, Schuyten, Claparede and Geux, Ivanof, and Rouma. Passy[2] and Perez[3] employ the method of direct observation of a number of children drawing under particular assignments. The results of their observations are among the earlier publications. Schuyten,[4] beginning in 1901, made a study of the evolution of the human figure in drawings by children from 3 to 13, using for the most part the special products method. He visited unannounced a number of schools at approximately the same time of day and requested the children to draw the figure of a man as they were in the habit of doing. The children were given entire freedom in their procedure. Schuyten obtained 20 series of drawings, 100 for each half-year period of ages running from 3 to 13 years, and divided equally among boys and girls. He utilized the materials as follows:

[1] Findley, Design in the Art Training of Young Children, 1906.

[2] Passy, Notes sur les Dessins des Enfants, 1891.

[3] Perez, L'Art et la Poesie chez l'Enfant, 1888.

[4] Schuyten, Het oorspronkelijk teekenen als bijdrage tot kinderanalyse, 1901.

1. By a lengthy and minute analysis of the manner in which the various parts, head, mouth, teeth, etc., were drawn, he established a qualitative coefficient of the degree of perfection of each group.

2. A most elaborate quantitative study was made by exact and detailed measurements of all anatomical variations in the head, nose, neck, trunk, hands, etc.

3. The development of artistic standards was ascertained by a comparison with classic ideals.

4. After many attempts the endeavor to establish types for the human figure at each age was abandoned.

Probst,[1] an instructor in a native school in Algiers, tested some of Levinstein's conclusions[2] in a study of a preparatory class of 53 Kabyle children of a tribe entirely free from European mixture. Probst first caused them to draw such pictures as they desired of their own accord. He then compared their choice of subjects with that of European children. In a second experiment he had them draw from memory a different type of object on each school day for four successive weeks. They drew one or more men on Mondays, a quadruped on Tuesdays, a bird on Wednesdays, a familiar scene on Thursdays, and what-

[1] Probst, Les Dessins des Enfants Kabyles, 1906.

[2] See later.

ever they pleased on Fridays. Probst's conclusions are not in accord with those of Levinstein.

Claparede and Geux[1] conducted a research in 1906 and 1907 in connection with the psychological seminar at the University of Geneva, which resulted in the collection of some 12,000 drawings from 3000 pupils. A questionnaire embracing definite instructions for procedure was distributed to a number of teachers. Under similar external conditions, pupils were directed:

1. To make a representative drawing of a chair or a stool placed in view of all.

2. To draw a cat from memory.

3. To illustrate the fable, *Le Corbeau et le Renard.*

4. To draw from choice whatever and however they wished.

Instructions were given to guard against copying, communication, and fatigue. All of the drawings were made with a pencil and ordinarily lasted five minutes. The instructors appended to the sheet of drawings of each child the sex, nationality, class, rank in class, general ability, subjects in which the greatest and least ability was shown, and remarks as to the mental type or additional peculiarities. The aim of the research was to answer a two-fold problem, (1) how taste and

[1] Claparede and Geux, Plan d'Experiences Collectives sur le Dessin des Enfants, 1907.

aptitude for drawing evolve, and (2) what correlation exists between aptitude in drawing and aptitude for work in general. The latter problem was assigned to one of Claparede's students, E. Ivanof,[1] who made a careful study of 9764 drawings from the original collection.

Rouma,[2] in connection with various classes of subjects in Belgium and Switzerland, has made an elaborate series of studies in which he makes use of diverse methods, the results of which are published in his book, *Le Langage Graphique de l'Enfant*, which contains one of the clearest treatments of the subject available. For the sake of unity, all of his study is mentioned here. The chief sources of Rouma's materials cover a period of years, as follows:

1. From October, 1900, to July, 1901, he gave two hours per day to the collection of drawings of eight children of rich parents. Part of the time was given to the collection of spontaneous drawings with the accompanying comments of the children, and part to the drawing of suggested themes, such as: When I was a little boy; The trip to the country; The soldiers.

2. From September, 1901, to July, 1905, Rouma had the following subjects treated by all the classes in a school for retarded children and in a number of schools for normal children.

[1] Ivanof, Correlation entre l'Aptitude au Dessin et les autres Aptitudes, 1908.

[2] Rouma, La Langage Graphique de l'Enfant, 1913.

(a) Man, woman, little boy, little girl, soldier, cavalier.
(b) The family house.
(c) A man walking with his little dog.
(d) A lady taking her baby a ride in a baby carriage.
(e) Two girls playing ball. One of them throws the ball through the window. It is broken.
(f) A thief escapes pursued by a gendarme. The thief carries a hen which he has stolen under his arm.
(g) Saint-Nicolas.
(h) Subjects from choice.

3. From September, 1901, to July, 1903, Rouma met a class of 40 pupils, aged 6 to 8, regularly one-half hour per week. The members drew alternately from free choice and dictation.

4. From September, 1904, to July, 1905, Rouma collected spontaneous and suggested drawings from a class of thirty backward children, aged 9 to 11, devoting six one-half-hour periods to this task per week. He also noted all comments which accompanied the drawings of certain selected pupils, discovering many factors thereby which escaped attention otherwise.

5. From September, 1905, to July, 1906, Rouma made a study of twenty-six abnormal children in a special class in Brussels. The drawings were made from choice and by way of interpretation of a given subject. The development of modeling and language was studied at the same time. Rouma calls attention to the

fact that the slower development of the stages of drawing among abnormal children makes possible a more detailed study of the individual steps. Paralleling this research, Rouma made a study of the drawings of the pupils of a Froebelian school and a primary school.

6. In 1908, under the personal supervision of Rouma, a number of teachers in the Froebelian schools of Charleroi kept a record of the spontaneous drawings and accompanying comments of selected pupils in their classes.

In addition to the above mentioned researches Rouma made studies of the pupils of other schools and of certain normal and abnormal children not attending school. His final treatment includes a discussion of the stages of evolution in drawing, the various characteristics of the drawing-image, the evolution of drawing as a form of language, the bearing of drawing upon intellectual development and attention, modeling, the culture of aptitude in drawing, and the place of drawings in the interrelations of race and species.

Among the leading German investigations of the special products type are those of Levinstein, Verworn, Kerschensteiner, Lamprecht, Kik, William Stern, Dück, and Wagner. The works of Levinstein and Verworn extend into and will be described under the comparative products method.

Kerschensteiner[1] made a monumental research

[1] Kerschensteiner, Die Entwickelung der zeichnerischen Begabung, 1905.

in the interests of reforming the drawing instruction in Munich. He aimed to discover (a) the entire course of the development of drawing from the first schema to the ultimate representation of space, and (b) the quality of representative expression attainable by children 6 to 14 years of age. In 1903 Kerschensteiner obtained 96,000 drawings from 7000 children of the Munich schools, 2500 of whom possessed special aptitude in drawing. The children were asked to represent as follows:

Trial 1. *From memory:* (a) the picture of their mother, their father, their own picture; (b) a horse, a dog and a cat, a bird; (c) an angel.

After nature: a child of the class.

Trial 2. *From memory:* (a) a flower, a tree; (b) a chair, a church, a tramway.

After nature: a chair, a violin, a pitcher.

Trial 3. A battle in the snow.

The 2,500 children with special talent in drawing represented:

(a) a man carrying a beam; (b) a woman carrying a water-cask; (c) a building of the village, *after nature.*

Kerschensteiner obtained the record of each pupil's age, ability, profession of parents, if possessed of a book of pictures, and if accustomed to draw at home. He concluded, however, that a

large number of the drawings had been subject to outside influence and instituted another series of tests in 1904, including in addition to the regular pupils a school of idiots and a number of kindergartens. In the second series he secured 100,000 drawings.

The drawings were classified according to a detailed sheet of instructions by the teachers. Kerschensteiner had all pupils showing marked talent draw in his presence afterward. When he was assured of the perfect fairness of the children's work, he began to collect documents which would aid in explaining this exceptional aptitude.

In a third series, 52,000 additional drawings were collected which had been used in the ornamentation of a book and a plate. Kerschensteiner made a number of supplementary tests to clear uncertain points, particularly in connection with perspective. The drawing instruction in Munich had been reorganized on the basis of the results of this research and Kerschensteiner's work is a distinct contribution to the psychology and pedagogy of drawing.

Lamprecht,[1] with the aim of contributing to the study of the history of civilization, beginning in 1904 at the University of Leipsig, initiated an international research upon a vast scale. Lam-

[1] Lamprecht, Les Dessins d'Enfants comme Source Historique, 1906.

precht sent a sheet of detailed instructions to various countries, involving the collection of the following types of drawings:

1. Spontaneous drawings of children who have not been influenced by suggestion or training.
2. Specified representative drawings of:
   (a) objects isolated in space, as a dog, table, flower, etc.
   (b) illustrated incidents, stories, etc.
3. Series of drawings from the same child.
4. Drawings of adults, particularly those with non-professional occupations.

For comparative purposes a large number of drawings were secured from the poem *Hans Guck-In-Die-Luft*, using the Barnes method. In addition data were collected as to the age, training, intelligence, and social position of the various subjects. A vast number of drawings were secured from Belgium, Sweden, Italy, England, Russia, Japan, America, India, and Africa, all of which have been classified and filed in the museum of the "Seminar for Culture and Universal History" at Leipsig. Levinstein (61) (see bibliography), Kohler (58), and Kretzschmar (59) have made researches in connection with the classification and interpretation of this vast body of material

Kik[1] made a study of thirteen drawers of mark-

[1] Kik, Die übernormale Zeichenbegabung bei Kindern, 1908.

edly exceptional ability, part of the subjects working in his presence. He gave particular attention to environmental influences and the relation between drawing aptitude and intelligence.

William Stern,[1] beginning in 1905, directed an inquiry at Breslau embracing the drawings of 1500 pupils, aged 6 to 18, from the primary, middle, and high schools. The pupils endeavored to interpret a poem of some fifty verses which had been read to them. The resultant drawings were analyzed as to (1) individual differences, (2) progress with age, (3) representation of space, (4) the problem of time, and (5) differences in sex.

Wagner[2] interpreted the foregoing material, classifying the possible motives of the drawings, giving percentages of frequency for representation of movement, human figure, indications of humor, etc., and characterizing the developmental stages of drawing.

Dück[3] made a special study of the interests of children in drawing and art, noting particularly the changes of interest at the time of puberty.

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[1] Stern, Spezielle Beschreibung der Ausstellung freier Kinderzeichnungen aus Breslau, 1906.

[2] Wagner, Das frie Zeichnen von Volksschulkindern, 1913.

[3] Dück, Uber das zeichnerische und künstlerische Interesse der Schüler, 1913.

III. The Comparative Products Method.[1]

The comparative products method arises out of various combinations of the gross and special products methods. Drawings which have been obtained from one group of individuals are compared to the products of some other group. The drawings are taken to be significant of certain psychological traits of the groups concerned. It is hoped to reveal the relations existing between the respective groups by means of a study of the similarities in the drawing products. In this way advantage is taken of groups of drawings already carefully organized, such as may be found in many ethnological studies.

There is no question that drawings may be utilized to reveal certain mental characteristics and thus prove valuable for comparative purposes. The validity of comparative generalizations, however, naturally depends upon the original method of obtaining the drawings. In view of this fact, considerable caution must be used in dealing with "gross products" drawings.

The comparative products method has been made use of by many investigators to enlarge the scope of their original researches. The most common contrast is the one made between a series of drawings of normal children with those of some

[1] Includes Ruttmann's "die ethnologische Methode."

other homogeneous group. In this manner the drawings of normal children have been compared with (1) the drawings of savages, (2) the drawings of prehistoric peoples, (3) the drawings of the pathologically degenerate, (4) the drawings of children of other races, (5) the drawings of illiterate adults, and (6) the art products of earlier periods of civilization. In addition numerous studies have considered the parallels existing between the sexes, between general ability and drawing aptitude, and between drawing and other types of expression, such as modeling, writing, and language. In making comparisons with the drawings of savages and prehistoric peoples, advantage is frequently taken of the materials collected and organized in such excellent studies as those of Danzel,[1] Haddon,[2] Koch-Grünberg,[3] Grosse,[4] Verworn,[5] Wilson,[6] and in the Annual Reports of the United States Bureau of Ethnology.

The researches of Schuyten, Probst, Ivanof, Lamprecht, Stern, and Kik, which utilize the comparative method in part, have already been mentioned. Levinstein[7] utilized the drawings

[1] Danzel, Die Anfänge der Schrift, 1912.

[2] Haddon, Evolution in Art, 1914.

[3] Koch-Grünberg, Anfänge der Kunst im Urwald, 1906.

[4] Grosse, The Beginnings of Art, 1897.

[5] Verworn, Zur Psychologie der primitive Kunst, 1908.

[6] Wilson, Prehistoric Art, 1896.

[7] Levinstein, Kinderzeichnungen mit Parallelen aus der Urgeschichte, Kulturegeschichte und Völkerkunde, 1905.

collected by Lamprecht in a study of the comparative type. Three of the eight chapters of his interesting book are given to a discussion of these parallels. Levinstein also treats in considerable detail the general question of children's drawings and appends an extensive bibliography in his publication. Gennep[1] has elaborated a special treatment of this type, and similar discussions may be found in Chamberlain,[2] Sully,[3] Wundt,[4] and Meumann.[5]

Max Verworn[6] began a study of the relationships existing between the drawings of children and primitive peoples in 1906. Verworn collected the drawings of a large number of rustic children, aged 6 to 14, believing that their environment made something of an approach to that of the primitive. The children drew from memory such familiar forms as a goat, cow, horse, sun, moon, man, and woman. In a second study Verworn had children copy drawings of the paleolithic age which represented reindeer and mammoths. Then followed a series of drawings in which the

[1] Gennep, Dessins d'Enfant et Dessins Prehistorique, 1911.

[2] Chamberlain, The Child, a Study in the Evolution of Man, 1900.

[3] Sully, Studies of Childhood, 1895.

[4] Wundt, Völkerpsychologie, 1900–09.

[5] Meumann, Experimentelle Pädagogik, 1914.

[6] Verworn, Zur Psychologie der primitiven Kunst, 1908.

children each time drew their previous drawing. Verworn sought by this parallel to clarify certain points in the serial development of primitive drawings.

Lobsien[1] repeated Schuyten's experiment to discover if a parallel existed between advance in age and an approach to the canons of art. He discards Schuyten's detailed measurements and selects the best and poorest drawers of ages 8, 11, 13, and 14. His conclusions vary somewhat from those of Schuyten.

The researches of Rouma and Levinstein in the field of the drawings of abnormal children have been mentioned. Rudolf Lindner[2] compared the drawings of deaf and dumb children with those of normal children by having the pupils of the Leipsig Deaf and Dumb Institute follow Kerschensteiner's directions for drawing a tramcar from memory.

IV. The Biographical Method.[3]

This method endeavors to obtain all of the facts connected with an extended series of drawings by individual children. The observer is familiar with psychological methods and keeps detailed

[1] Lobsien, Kinderzeichnung und Kunstkanon, 1905.

[2] Referred to by Meumann, Experimentelle Pädagogik, Bd. III, p. 758.

[3] Compare Luquet's "méthode microscopique."

records of the subjective phenomena accompanying the drawings of the same child for a period of several years. For the most part this method has been used in studying the spontaneous drawings of children prior to the influence of special instruction. More recently this has been varied by the introduction of special themes for interpretation or has been extended into the school period. The biographical method is practically free from the sources of error common to the exclusively objective methods and, in connection with other methods, offers a most fertile field for investigation. Many excellent researches have been made with biographical material.

An early study of this type was made under the direction of Elmer E. Brown,[1] who interpreted four extended studies of the drawings of individual children Miss M. V. Shinn followed the drawings of a child from the 27th to the 64th month, Catherine W. Slack watched a second child from the 36th to the 60th month, Eleanor G. Sharp studied a third child from the 28th to the 60th month, and Lulu M. Chapman, a fourth child from the 32d to the 48th month. Brown collected data on the development of each child from the following points of view: (1) circumstances at the beginning of drawing, (2) degree of representation, beauty, and symmetry in the drawing, (3) first

[1] Brown, Notes on Children's Drawings, 1897.

attempts at copy drawing, (4) child's attitude toward drawing, (5) symbolism, (6) conventionalism, (7) size, direction, and form of outlines, and (8) changing interests in form and color.

Louise Hogan[1] made an extended bibliographical study of the drawings of a child up to the age of eight, treating both spontaneous and suggested drawings. Lukens[2] followed the drawings of a little girl from the 27th to the 56th month. His treatment contains a very good summary of studies of children's drawings up to that time.

C. and W. Stern[3] traced the developmental stages in drawing by the study of the early drawing periods and artistic interests of a little boy. Luquet,[4] using what he terms the "méthode microscopique," has made the most elaborately detailed study of the biographical type up to the present time. His book of 262 pages and 150 plates of drawings contains a very complete analytical account of the development of the drawings of the little girl, Simonne Luquet, from a little over three years of age to nearly nine. Luquet collected a series of over 1700 drawings with the accompanying comments and made a careful

[1] Hogan, A Study of a Child, 1898.

[2] Lukens, A Study of Children's Drawings in the Early Years, 1896.

[3] C. and W. Stern, Die zeichnerische Entwickelung eines Knaben, 1909.

[4] Luquet, Les Dessins d'un Enfant, 1913.

record of all subjective conditions. Other researches involving the biographical method have been made by Baldwin,[1] Moore,[2] Preyer,[3] Sully,[4] and others.

V. The Experimental Method.

The experimental method attempts to analyze the process of drawing by setting up a definite and precise control of the drawing act which takes into account the subjective as well as the objective aspects of drawing. It attempts to measure the response of individual drawers to known and controllable conditions. As distinguished from objective methods, very careful attention is given to the inner mental conditions of the individual subjects. The attempt is made to determine individual variations in such subjective factors as perception, type of imagery, memory, endowment, and training. In general, the problem is to reduce the drawing process to its elements for purposes of ultimate analysis of the ordinarily synthesized activity by the employment of the methods of experimental psychology.

In the majority of existing researches the methods of control have been but partial at best, but,

[1] Baldwin, Mental Development in the Child and the Race, 1897.

[2] Moore, The Mental Development of a Child, 1896.

[3] Preyer, The Mind of the Child, 1899.

[4] Sully, Studies of Childhood, 1895.

as a whole, the results obtained by the experimental method are of the greatest significance both to the psychology and the pedagogy of drawing. The chief researches follow.

Judd and Cowling[1] made an experimental analysis of the various elements which enter into the process of the visual perception of a simple figure. A small linear figure composed of four straight and three curved lines was exposed to the view of a number of subjects for a period of ten seconds. The subjects immediately afterward attempted to reproduce the figure in a drawing. The figure was then exposed again and a second drawing attempted. This process was repeated until the subject had attained an approximately correct percept of the figure. By a comparison of the objective results with the introspections of the various subjects, the investigators were enabled to trace the development of the perceptual process and the ability to reproduce the figure graphically.

Katz[2] studied the individual differences in representative drawing among children by having three girls of 5, 6, and 7 years draw in succession with ruler and pencil the following models made out of blue pasteboard: (1) triangle, (2) quadrate, (3)

[1] Judd and Cowling, Studies in Perceptual Development, 1897.

[2] Katz, Ein Beitrag zur Kenntnis der Kinderzeichnungen, 1906.

parallelogram, (4) ellipse, (5) circle, (6) cube, (7) flat quadrate with four supports in the form of a four-legged table, (8) three-sided pyramid, (9) regular tri-lateral. In a second series of drawings Katz investigated the elements of the perceptual process and attention which gave rise to the peculiar characteristics of individual drawings.

Albien[1] has contributed an elaborate experimental study concerning the elements entering into the drawing act which is of first importance to the psychology and pedagogy of drawing. The experiments were carried on with individual pupils in Albien's home. The first was conducted by Meumann. The others were taken up during a period of about eight weeks, during which Albien tested from two to four pupils daily. The process of representative drawing from copy was taken to consist of two major processes: (1) the optical-perceptional part, and (2) the graphical-reproductive part, involving the representation of the previously apprehended and assimilated optical images. Each of these major processes was taken to consist of a number of subordinate elemental part-processes. (See discussion later.)

The aim of Albien's research was to set up an experiment which would isolate the various part-processes of the drawing act. To this end figures

[1] Albien, Der Anteil der Nachkonstruierenden Tätigkeit des Auges und der Apperception an dem Behalten und der Wiedergabe einfacher Formen, 1907.

were selected for "copy" which provided for the following considerations:

1. The resemblance of the "copy" to known figures was controlled so as to reduce the play of memory to a definite minimum. Three figures were selected for copy; the first being practically foreign to the previous experience of the subjects, the second resembling the contour of known forms, and the third of medium difficulty.

2. The constructive activity of the eye and hand movements and of the apperceptive processes was controlled by artificial interruption. Eye movements were excluded, when desirable, by means of a definite fixation point marked on the copy. The involuntary drawing movements of the hand during preliminary perception were excluded by rhythmic movements of the hands.

3. An attempt to exclude the will during perception was made by asking the pupils not to think about drawing the object during the process of fixation.

The experiment as a whole was carried on in three chief parts.

Part I. Drawing After Fixating Seeing (Zeichnen nach fixierenden Sehen).

In this part of the experiment each of the three types of copy was exposed by means of a tachistoscope for a period of ten seconds (repeated when desirable), during which time the eye was kept

fixed upon the fixation mark near the center of the figure, all of the figure, however, lying within the field of the subject's vision. The subject then attempted to reproduce the image of the copy by drawing it. The subject was then asked:

"Do you consider the drawing to be correct?"

"Can you tell what is wrong? Where is anything lacking?"

"What is the cause of it? Is it that you cannot see accurately and cannot draw satisfactorily?"

Part II. Drawing from Memory (Nach der Vorstellung aus dem Gedächtnis).

Each subject was permitted to observe the copy until he thought he could draw it from memory. The drawing was then executed. The time of the observation and execution was recorded and the following questions asked:

"Is the drawing difficult? Why? or, What is the cause?"

"Upon what do you depend in memory drawing?" Other questions are supplemented according to individual needs.

Part III. Representative Drawing from Copy (Abzeichnen der Vorlage).

In conclusion each figure was drawn with the copy in view. The time of drawing was recorded. All subjective manifestations were recorded throughout the entire experiment.

The subjects for the experiment were selected by Albien from a local *real*-school and included classes Sexta to Untersekunda, with the following age distribution:

Sexta	9 subjects	9–10 years	
Quinta	9	"	11–12 "
Quarta	10	"	13–14 "
Tertia	9	"	15–16 "
Untersekunda	8	"	17–18 "

The pupils in the Sexta had had no lessons in drawing. The others had received two hours per week in freehand drawing. From the original classes, containing about fifty pupils each, Albien selected one good, one medium, and one poor drawer with good general intelligence, and one good, one medium, and one poor drawer with poor general intelligence. In conclusion Albien analyzed the various types of drawers and the effects of endowment, perserveration, the feelings, and reflection, upon drawing.

Stiehler[1] made an instructive experiment to determine the relation between construction and drawing, with the particular aim of distinguishing between the physical concept and the drawing concept attaching to the same object. The experiment, having eighteen children as subjects, was conducted in two parts.

[1] Stiehler, Beitrage zur Psychologie und Methodik des Zeichenunterrichts, 1913.

1. Each child placed a match-box at a distance of about 60 cm. in such a manner that it stood obliquely and lower than the eyes. The children were admonished to note the number of surfaces, their arrangement, size, and form; and at the same time, however, they were not to turn their heads in order that the perception might always occur from the same visual angle. Nothing was said with regard to perspective phenomena, foreshortening of size, and shifts in form. After observation and general deliberation, the box was set aside. It was then drawn from memory.

2. The match-boxes were then touched, rubbed, pressed, relaxed, turned; there was counting, measuring with strips of paper, comparison; first with the eyes closed, then open. The representation was then made from memory.

The results of these two tests were interpreted in light of the accompanying remarks of the subjects.

Peter[1] has recently experimented with an analysis of the elements attached to the mastery of the perspective relationships in drawing objects which are situated back of other objects. Peter required the pupils to draw a scene viewed through an intervening window.

Beside the part played in Albien's experiments, Meumann[2] records in his treatment of *The Ana-*

[1] Peter, Beitrage der Analyse der zeichnerische Begabung, 1914.

[2] Meumann, Vorlesungen zur Einführung in die Experimentelle Pädagogik, 1914.

lysis of Drawing two further experiments worthy of note here. In the first series Meumann had a group of subjects draw from memory a number of familiar objects. Certain of the subjects were then directed to describe the objects from memory, or, failing in this, to describe the objects when pictures of them were placed before them. Various individuals were questioned as to their difficulties in drawing from memory. In addition, individual hand dexterity was studied and a comparison was made of the memory (auswendig) drawings following short and long exposure.

In a second series of experiments directed by Meumann, an attempt was made to classify the types of drawing retention and the elemental processes of the drawing act. In this study objects of gradually increasing difficulty were presented for representative drawing (Abzeichen). These included such objects as a piece of lime-spar lying upon a cigar box, and a cigaret box with crayon and inkstand. The following types of drawing were secured:

1. After the subject announced that the exposure had been long enough for sufficient observation, the object was covered and drawn from memory.
2. Out of recollection, usually one day later, of the first attempt.
3. From memory after an exposure of one minute.

4. The same object as in *3* after one day.
5. From memory after an exposure of about ten seconds.
6. From memory after a tachistoscopic exposure of about one-half second.
7. Objects from which all subjective construing had been excluded.
8. From the recollection of a picture, such as, *The Birth of Christ.*
9. After an attempt at influencing the memory by suggestion.

Immediately after each drawing each subject was asked questions to bring out individual variations in the subjective elements of the drawing act. Finally a stamp, the Hamburg escutcheon, and the subject's own pocketbook were drawn from memory. The subjects were also tested in hand skill and types of imagery.

Chapter III

STUDIES IN THE RELATION OF DRAWING TO INTELLECTUAL DEVELOPMENT

I. Industrial versus Cultural Values.

The rise[1] of drawing in the public school program of studies has been due to two more or less conflicting art interests, the industrial and the cultural. Drawing made very little headway in the United States until emphasis upon its economic value secured the support of such educational leaders as Horace Mann and Henry Barnard. The publication of a number of foreign articles on the value of drawing together with the public-spirited work[2] of such men as William Bentley Fowle, Rembrandt Peale, and William Minifie, kept an interest in public school drawing alive, but until 1870 progress was practically counteracted by a widespread conception of drawing as an "amusing exercise."

In 1870 the state of Massachusetts enacted a law which states that "mechanical and industrial"

[1] No attempt is made here to give even a summary of the historical rise of drawing, an account of which may be found in Jessup, Clarke, Haney, or Farnum. (See bibliography.)

[2] Haney, Development of Art, pp. 21–33.

drawing may be freely taught in any city and town, and free instruction must be given in cities and towns of over 10,000 inhabitants. This was followed by the selection of Walter Smith of the School of Arts in Leeds, England, as State Agent. Smith was a few years later made director of the newly established Massachusetts Normal Art School.

> "As directors of the foremost Art Schools, State Supervisors, city directors, editors and writers, craftsmen, painters, sculptors, and architects, the alumni of this particular school and their children of one and two generations lead in the art world of the United States today."[1]

The Massachusetts movement spread rapidly to other states, but the great emphasis given to mechanical and industrial drawing was followed by a reaction, chiefly on the part of teachers, toward an emphasis of the intellectual values of drawing. This is well illustrated in a quotation cited by Jessup.[2]

> "The old style of drawing consisted principally of picture making from copies. The new is an intellectual study; the thought, ingenuity, and invention of the scholar in the line of art as supplied to industrial pursuits. The influence of this branch is manifold; it especially

[1] Farnum, Present Status of Drawing and Art in Schools, p. 18.

[2] Jessup, Special Supervision in the Public Schools of the United States, p. 29.

develops: (1) observation; (2) forethought; (3) painstaking; (4) taste, imagination; (5) memory of forms; (6) power to discriminate—judgment; (7) ease and precision in the movements of the hand. As drawing is opposed to carelessness, haste, bad forms, and clumsy execution, it is a valuable art in teaching writing." Report of the Schools of Erie, Pennsylvania, 1877–78.

The prevailing belief in the disciplinary value of drawing is summarized in Clarke's voluminous work[1] in 1888 as follows:

"The value of drawing as a means of mental discipline is believed to be not inferior to that of any of the studies at present included in the curriculum of the public schools. It is, therefore, not only because of its direct application to the industries and art and hence of economic value to the pupil, that this study of drawing has a claim to admission into the public schools. Its value as a means of developing and training the intellectual faculties is so well established, from the professional point of view of the teacher, and, regarded merely as an instrument of pedagogics, the progressive system of . . . industrial drawing can readily establish its claim for introduction into the elementary course of instruction on educational grounds alone."

A value of drawing which is of greater cultural breadth than the so-called intellectual value, and which may be called the aesthetic value, received

[1] Clarke, I. E., Art and Industry, Part I, CXXII. See Jessup, p. 29.

widespread acceptance through the interest in design and decoration stimulated by the art exhibits of the World's Fairs at Chicago in 1893 and St. Louis in 1904. With the development of this interest there has been a marked tendency to correlate the cultural and industrial work in the school arts which has resulted in a realignment of the values of drawing.

Henry Turner Bailey[1] gives the following reasons for requiring drawing in the public schools:

"1. Drawing is a language of form: (a) graphic recorder of scientific fact; (b) expression of constructive and decorative art; (c) medium for expression of ideas of artistic beauty.

"2. Practice in drawing promotes: (a) close observation, thus insuring clear mental images; (b) muscular control or skill of hand; a prerequisite in the practice of any craft; (c) a knowledge of the elements of beauty in nature and art, the basis of design, and the grounds for intelligent taste and appreciation.

"3. The study of drawing opens the mind to the treasures of nature and the various arts; increases the pleasure and general significance of life."

In contrast to this, Sargent's[2] analysis of drawing as representation differentiates the following values:

[1] Bailey, Monroe's Cyclopedia of Education, 1912.

[2] Sargent, Fine and Industrial Arts in Elementary Schools, 1912.

1. General. "Drawing is a language, a mode of reproducing ideas, and as such is a means of forming and developing these ideas." "Drawing develops ability of concrete habits of thought." "Drawing stimulates the mental activity of children."

2. Industrial. "To the man engaged in constructive work, drawing offers a means of endless experimentation."

3. Scientific. "In scientific studies drawing focuses the attention upon, and quickens observation of, facts of form and structure, rendering the senses more accurate in their testimony and furnishing a means of making definite records."

4. Aesthetic. "Representation is also the language of the fine arts of painting and sculpture."

R. B. Farnum,[1] who has recently made a thorough-going investigation into the status of drawing and art in the elementary and secondary schools of the United States for the Bureau of Education and is probably more familiar with the general situation than any other man in the country, states that:

> "The broad and general purpose of culture through art education may be roughly subdivided into three distinct aims. . . which are universally agreed upon. Such an education should train (a) in expression, (b) in observation, (c) in appreciation."

[1] Farnum, Present Status of Drawing and Art in Schools, 1914.

(a) Expression. "As an outward expression of the mental processes, the value of the study of art lies in stimulating the finest ideals and in giving command of the best means of expressing them."

(b) Observation. "Keen and accurate observation, then, is fundamental to art and is an asset in the broadest sense. It calls for close analysis and stimulates the initiative of the discoverer."

(c) Appreciation. "Appreciation as applied to master creations of the artist in architecture, sculpture, painting, to the forms of minor art seen in the works of the craftsman, to nature, to the very environment of the person himself, is the third aim in art education."

With these several aims of drawing in mind, it is interesting to note the emphasis that is given to technical ability in college entrance requirements. The following university entrance requirement[1] must be met by candidates who apply for five credits in freehand or mechanical drawing:

Freehand Drawing. The applicant must possess ability:

1. To make rapid sketches from objects which shall indicate the perspective appearance, the proportions, and the main characteristics of structure and form.

2. To make as records of observations such drawings as would be appropriate for illustration to accompany high school studies in the sciences.

[1] University of Chicago Entrance Requirements, 1912.

3. To sketch freehand, from specifications, any simple geometric figure.

4. To match with water colors any given color, or to carry a flat wash of color over a given area.

Mechanical Drawing. The applicant must possess ability:

1. From a given mechanical drawing of a simple object to make a freehand drawing of the appearance of the object in perspective.

2. From a simple geometric form or constructed object to make dimensioned freehand working drawings which furnish data sufficient for a finished instrumental drawing or for the construction of the object.

3. From specifications to make a completed working drawing, freehand or instrumental, or a sketch of the appearance of the object.

It should be stated here that outside of art and technical schools individuals are rarely found who measure up to the standards of the foregoing aims and requirements.

II. Scientific Values.

Attention was called in the introductory chapter to the fact that representative drawing is esteemed by many teachers as a useful device for securing analytical observation. This conception of the value of drawing is more specifically disclosed in the following list of typical quotations from laboratory manuals and relevant literature:

Spencer, Education, 1861. Drawing is "a means whereby still greater accuracy and completeness of observation is induced."

Johonot, Principles and Practice of Teaching, 1878. "Drawing is of the highest use to all intellectually in inciting to correct observation."

Bergen, Note-book to Accompany Botany Texts, 1904. "Sketch every thing that can be drawn, and then explain in writing all points not evident from the sketches."

Ganong, The Teaching Botanist, 1900. "The very act of drawing will call attention to features otherwise overlooked."

Maxwell, The New Course of Study, 1904. "Use drawing wherever possible and particularly in nature study, for there can be no proper study of these objects unless they are drawn. This is absolutely essential."

Hardest, Laboratory Guide for Histology, 1908. "In drawing one learns to practice habits of neatness and astuteness of observation."

Conn, Biology, 1912. "In all cases where laboratory work is possible, students should be required to make careful drawings of the objects."

Curtis, Laboratory Directions in General Zoology, 1912. "Drawings are used solely as a means of enforcing exact observation and recording the results of the same."

Bastin, Laboratory Exercises in Botany, 1895. "They [drawings] are useful not only in explaining to others the structures observed, but they are in themselves great aids also to accurate observation, and are equally helpful in

giving vividness and permanency to knowledge."

Hall, The Teaching of Physics, 1913. "Practice of the graphical method of record, by means of the simplest possible drawings, is of very great service; for it requires the pupil really to study his apparatus, and yet, by saving many words, may save his time as well as that of the reader."

The use of drawing as a device for recording the work accomplished by the pupil is practically universal.

Ganong, The Teaching Botanist, 1910. "He can not make even a passable scientific drawing or written description of an object until he has first seen it accurately and completely, and realized its construction." "For his purpose both drawings and descriptions are needed."

Bigelow, The Teaching of Zoology, 1907. "The ideal record of laboratory work in zoology consists of both drawings and notes."

In spite of the common belief in the efficacy of representative drawing to secure analytical observation, there is a growing realization among those who have given more thought to laboratory practice that the purely representative drawing does not accomplish this purpose.

Ganong, The Teaching Botanist, 1910. "It is essential for the teacher to realize that scientific drawing does not consist in the composition of pictures correct in perspective and fine

finish, but in the making of diagrammatic outlines which convey to the mind of the beholder accurate conceptions of the real construction of the object represented."

Bigelow, The Teaching of Zoology, 1907. "Drawings, like the structures they represent, lend themselves chiefly to the training in observation. For sound training in induction we must have notes . . . clearly written, logical accounts of observations, experiments, and conclusions."

To these quotations should be added one of Luquet's conclusions.[1]

"For to set limits to the sense of observation, it is certain that in making the child draw one attracts his attention to motifs in which he was perhaps not interested by himself. But if we consider here drawing as an element of 'object lessons,' logical realism is infinitely more adapted to this role than visual realism, since it consists precisely in placing in the drawing all that is in the object, and to typify all of the elements, each with its exemplary form, and by logical realism the child in some way spontaneously effects the dissection of the object which he reproduces."

III. Relation of Drawing to Special and General Aptitudes.

Many writers have called attention to the value of drawing as a means of studying the intellectual

[1] Luquet, Les Dessins d'un Enfant, pp. 250–51.

development of the child. The spontaneous drawing in particular serves as a definite form of expression to reveal many conditions of the child's mental life and growth which are otherwise inaccessible. Here, as with all children's drawings, it is unwise to build too much upon group collections unless augmented by the acts and remarks of the children while drawing and by series of drawings from the same children.[1]

The relation which exists between ability in drawing and ability in other subjects and other modes of expression is an interesting question which bears directly upon our general problem. The literature of drawing contains abundant comment concerning the relation of drawing to other subjects, as well as to general intelligence, but there is very little in the way of exact experimental investigation.

Miss Elderton[2] compared 19 boys in the Fourth Form of an English public school as to abilities in Drawing and Classics and obtained a correlation of .416. With the same number of boys in the next higher form, the Remove, she obtained a negative correlation of —.313. Waiving criticism as to the manner of obtaining the original grades, the small number of subjects, nineteen, in this

[1] Rouma, Le Langage Graphique de l'Enfant, p. 157.

[2] Elderton, On the Association of Drawing with Other Capacities in School Children, Biometrika, 1909.

study permits chance to play so large a part in the ultimate correlation discovered that the figures given are practically without value.

The most pretentious attempt in this field is the study of M. Ivanof,[1] which embraces 9764 drawings. The correlations were made according to age and not by grade in school. The valuation of the drawings was based upon three factors: (1) accuracy of proportions, (2) imaginative conception, (3) technical and artistic value.

The individual drawings were graded from perfect down to worthless on a scale of points: 6, 5, 4, 3, 2, 1, and 0. Each drawer was eventually classified from the average of four drawings graded separately into one of three groups:

1. Good drawers (Average 6 or 5).
2. Medium drawers (Average 4 or 3).
3. Poor drawers (Average 2, 1, or 0).

Table I expresses the final results:

The results shown in this table indicate that ability in drawing is positively correlated with general ability, particularly among the girls. The results are, however, open to criticism on account of the possible variability of the original grades in the various branches. These were obtained on the basis of the individual judgments of a number of different teachers and not by accurate psycho-

[1] Ivanof, Correlation entre l'Aptitude au Dessin et les autres Aptitudes, 1908.

TABLE I

Correlation Between Aptitude in Drawing and Work in General

The figures show the percentage of pupils in each group who were strong students in general work.

Strong Pupils		Berne	Geneve	Neu-chatel	Vaud
Boys	% among all pupils.....	33	33	34	32
	% among good drawers.	45	40	34	54
	% among poor drawers.	29	22	15	15
Girls	% among all pupils....	36	32	39	35
	% among good drawers.	60	48	100	68
	% among poor drawers.	30	12	22	18

logical tests. Moreover, the three factors used for grading the drawings are widely variable and afford a source for misinterpretation of the final results. Ivanof also estimated the correlation between drawing and a number of other school subjects.

1. *Drawing and Writing.* (a) Of boys who are good in drawing, the percentage good in writing is higher and the percentage poor in writing is much lower than with the average of the pupils. (b) The correlation is less clear with the girls, since the percentage of good girl drawers who are poor in writing (18%) is practically equal to the average (17%). (c) Including all, there is a positive correlation.

2. *Drawing and Geography.* (a) Boys are more often better, and less often poorer, than girls. (b) There is a positive correlation between

drawing and geography with both boys and girls. This correlation is easily explained, because the study of geography involves the memory to a great extent.

3. *Drawing and History.* Conclusion. It is not easy to explain the strong correlation which we have found between history and drawing. It may come from an indirect correlation; perhaps those good in history, like those good in drawing, are those who know best how to construct mentally the visual schemas of events, scenes, objects.

4. *Drawing and Calculation.* The correlation is clearly present with the girls; it is less marked with the boys. With the pupils at Vaud the results are antagonistic.

5. *Drawing and Manual Arts.* Large correlation present. This is easily explained. It implies many of the same physiological factors: exactness of the visual sense, precision in hand movements, aesthetic taste.

6. *Drawing and Language.* Contradictory reports from canton to canton. Ivanof concludes the correlation is uncertain.

7. *Drawing and French Composition.* The results show a positive correlation.

All of the results above are open to a number of criticisms which will be discussed in greater detail in connection with a similar personal research. (See Chapter VI.)

Kik,[1] in the course of his elaborate study of thirteen unusually talented drawers, makes the

[1] Kik, Die übernormale Zeichenbegabung bei Kindern, 1908.

following statement with reference to the relation between talent in drawing and the degree of general intelligence:

> "It is easy to comprehend that mechanical copying as merely skill of hand has nothing to do with general intelligence and that a good copyist may be a poor scholar. In general, the pure copyists are weak pupils in the scientific branches. As the number of copyists is sufficiently large, and since they formerly obtained the best marks, one has been able to say, 'A good drawer is a poor scholar.' But in reality it is the statement of Kerschensteiner which is true: 'A great talent of graphic expression is regularly associated with the child of good intelligence.' The activity of the memory and the imagination in drawing proves that it is intellectual work and that a great talent for drawing is always the sign of a developed intelligence. Experience demonstrates it. The good drawers show a good or satisfactory faculty for the scientific branches; they have certain strong subjects and certain weak subjects. Often the good drawers are strong in the natural sciences. Favored by their love of nature, they have acquired a mass of empirical knowledge and attend the lessons with interest. The drawers of imagination are excellent in style and obtain good marks in German; literature pleases them; there they find material for drawing. Preoccupied with concrete objects, they have a certain weakness for the abstract sciences: mathematics, algebra, geometry. Finally, they are not brilliant in oral expression, habituated and tempted as they are to express themselves by drawing."

Rouma[1] agrees with the general trend of these conclusions, but Albien,[2] after a careful experimental study of the drawing act, says:

> "The foregoing experiments give no confirmation to the thesis which Kerschensteiner upholds: very great talent for graphic expression is positively correlated in children with good intellectual endowment. For the pupils in the foregoing attempts did not show equally notable intelligence and good drawing talent. The most talented boy in drawing ranks 29 in a class of 46."

These contradictory reports result in great part from different interpretation of the meaning of the word *drawing*. Ivanof includes under drawing factors of imagination and aesthetic interpretation, while Albien's experiments restrict drawing to pure representation. Kik specifically denies good intelligence to the copyist and claims it for the artist. It is probable that drawing, as an art, is characterized by some of the same factors which enter into "general intelligence," while drawing, as mere representation, is relatively specialized. The conclusions of two studies in general intelligence bear upon this question.

Terman[3] tested seven of the brightest boys and

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[1] Rouma, Op. cit., p. 198.

[2] Albien, Op. cit., p. 33.

[3] Terman, Genius and Stupidity, Pedagogical Seminary, 1906.

seven of the dullest boys in a group of five hundred elementary school pupils in (a) powers of invention and imagination, (b) mathematical ability, (c) mastery of language, (d) insight, (e) ease of learning the game of chess, (f) memory, and (g) motor ability. He concludes that the bright boys are superior to the dull boys in all mental tests and inferior in the motor.

Simpson[1] investigated the correlation present in a variety of mental abilities which he groups roughly under the heads: sense-discrimination, motor control, efficiency in perception, efficiency in association, memory, and selective thinking. Upon the basis of his own and previous experiments Simpson concludes:

> "We find justification for the common assumption that there is a close interrelation among certain mental abilities, and consequently a something which may be called 'general mental ability' or 'general intelligence'; and that, on the other hand, certain capacities are relatively specialized, and do not necessarily imply other abilities except to a very limited extent."

Whatever correlation may exist in general between talent in drawing and other intellectual capacities, it is quite evident that there are numerous individual cases where a high state of intelli-

[1] Simpson, Correlation of Mental Abilities, 1912.

gence is not a sign of superior drawing ability. Not only is this true, but it is not particularly uncommon to find cases of extreme negative correlation between drawing ability and other manifestations of intelligence. Rouma's[1] tests with weak-minded children show that subjects with feeble intelligence sometimes have very strong visual memories and make slowly achieved drawings which are remarkable in perfection of detail. In contrast to this, Stiehler[2] records that he has two sculptors in his Seminar practice school who have no ability in drawing whatever, and Meumann[3] describes an adult specialist in psychology whose drawings are entirely without representative value.

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[1] Rouma, Op. cit., p. 199.

[2] Stiehler, Psychologie und Methodik des Zeichenunterrichts, p. 35.

[3] Meumann, Experimentelle Pädagogik, III, p. 750.

Chapter IV

STUDIES IN THE ANALYSIS OF THE DRAWING PRODUCT

I. Gross Products.

Many investigators have been interested in the broad question of *what* children draw and numerous analyses of large collections of drawings have been made upon this basis. A typical example is the study of 1570 drawings by Mrs. Maitland.[1] The drawings were obtained by asking children to draw what they pleased. The drawings were then collected and classified as shown in the following table:

Table II

What Children Draw Spontaneously

The figures indicate the number of children who drew the type specified at the various ages.

Type	5–7 yrs.	8–10 yrs.	11–13 yrs.	14–15 yrs.
Human figure.....	45	40	8	5
Animals.....	23	21	11	10
Plants.....	35	30	17	11
Houses.....	32	30	13	4
Mechanical.....	8	13	11	8
Still life.....	40	47	39	31
Geometric design.....	5	12	28	37
Ornament.....	3	3	4	8

[1] Maitland, What Children Draw to Please Themselves.

Levinstein[1] finds similar results in a gross analysis of several large collections of drawings. At early ages children prefer to draw the human form. As age increases, animals, plants, and diverse objects respectively gain a larger place in the drawings. In all cases it is the familiar animal or plant which receives the highest percentage of representation.

On the other hand, Probst,[2] in a study of the spontaneous drawings of the native children of a Kabyle tribe in Algiers, finds that animals are drawn in preference to the human figure. Probst asserts that the matter of choice varies with the race and that it is dependent upon local tradition and environment.

The evolution of the representation of the human figure affords material for the analysis of the development of a specific type. Lena Partridge[3] has catalogued the variations of the different child ages in detail.

These statistics indicate that there are a number of well-marked general stages in the evolution of the representation of the human figure. At early ages the child has little idea of form, proportion, or visual representation. The simple notions gradually include more and more detail

[1] Levinstein, Kinderzeichnungen.

[2] Probst, Les Dessins des Enfants Kabyles.

[3] Partridge, L., Children's Drawings of Men and Women.

TABLE III

What Children Draw in Representing the Human Form

The figures give percentages of children at each age.

Ages	4	5	6	7	8	9	10	11	12	13
Body.....	50	82	92	93	98	99	98	99	100	100
Feet.....	39	83	92	93	94	98	98	97	98	98
Arms.....	45	67	71	80	76	75	93	90	95	95
Neck.....	8	22	20	37	51	63	79	79	90	93
Hair.....	6	26	27	32	38	58	70	65	73	82
Beard.....	1	12	15	12	18	34	40	36	60	51
Feet profile...	15	54	66	73	78	87	83	85	79	85
Nose profile...	6	34	46	65	76	79	81	81	77	76
Body profile...	1	5	7	16	30	36	41	50	59	62
Hat.....	32	57	59	76	78	81	84	89	85	80
Buttons.....	30	37	37	52	55	66	64	81	79	83

until approximately complete. The change from full-face representation to profile is a marked characteristic in the development of the human figure.

Levinstein[1] makes similar generalizations from a large array of drawings. The biographical studies of Rouma[2] and Luquet[3] indicate that the representation of animal as well as human forms passes through a series of stages which appear successively.

[1] Levinstein, Op. cit.

[2] Rouma, Le Langage Graphique de l'Enfant.

[3] Luquet, Les Dessins d'un Enfant.

Many students have been interested in the *way* in which children draw. There is a considerable mass of literature devoted to the study of the child's difficulty with the factors of time, orientation, opacity, proportion, space, perspective, and movement. The majority of children master these problems in similar fashion.

Rouma[1] distinguishes four stages of development in the representation of movement.

1. The drawings are stereotyped, indicating merely that a man or an animal is being represented. The child announces verbally what the motion is. "The man runs."
2. The second stage shows movement by some form of relationship. A line is drawn from the stereotyped form of a dog to a house, which indicates that the dog is going to the house.
3. The movement is partially indicated in the drawing. A raised leg, with the remainder of the figure stereotyped, shows that a man is running.
4. The entire drawing depicts motion.

The following table is taken from Rouma. The figures indicate the variation in representation of motion by ages. The tests were given to five classes in a Molenbeek school for girls.

[1] Rouma, Op. cit., pp. 86–104.

TABLE IV

Representation of Motion

The figures indicate the number of children of different ages.

Ages	First Stage Neutral	Second Stage Relative	Third Stage Partial	Fourth Stage Complete
First Grade—33 pupils				
6 yrs....	3	15	0	0
7 yrs....	0	5	0	0
8 yrs....	1	5	2	0
9 yrs....	1	1	0	0
	5	26	2	0
Fourth Grade—26 pupils				
9 yrs....	0	0	3	1
10 yrs....	0	1	3	2
11 yrs....	0	0	2	3
12 yrs....	0	0	3	6
13 yrs....	0	1	0	1
	0	2	11	13

These statistics show that, while there is a general parallelism between advance in age and the ability to represent movement, there is great variation among individual pupils. Different children of the same age appear in three different stages of drawing.

Levinstein[1] tabulated 4943 illustrations of *Hans Guck-in-die-Luft* upon the basis of the manner of drawing. As a result he distinguishes two chief types of drawings. (1) *Fragmentbilder* (fragment-pictures) and (2) *Erzählungsbilder* (narrative-pictures). The illustrations of a child of six years afford a pure example of the *Fragmentbilder*. No actual scene is represented, but the illustration is composed of isolated figures scattered over the paper entirely without organization. At older ages the children begin to produce the *Erzählungsbilder*. The scenes of the story are now distinguished and arranged according to the sequence of the phrases of the story, a scene for each phrase in chronological order. Levinstein found that this type is begun at the age of 9 or 10, and that at 11 or 12 it is the chief type of the children's illustrations.

Rouma[2] made a similar test to satisfy himself of the true worth of Levinstein's conclusions. Rouma had the story of the *Petit-Poucet* related to the children as the scenes were shown by the cinematograph. He found that the *Erzählungsbilder* gradually displaced the *Fragmentbilder* in the children's illustrations according to the increase in age, but that it occurred at an earlier

[1] Levinstein, Op. cit.

[2] Rouma, Op. cit., p. 150.

age than Levinstein had found. In addition he made a very significant discovery by asking some of the children who always drew *Fragmentbilder* to act out the story. He found that they could act out all of the scenes in complete detail. He then had them draw again, but they were unable to make other than the fragmentary illustrations. The fact that the children knew all about the story, but could not make the drawings, shows that the type of drawing does not indicate the child's knowledge. His physical behavior, therefore, does not depend upon clear visual images of the scenes of the story.

II. Stages in the Development of Drawing.

We have seen that it is possible to distinguish a number of developmental periods in the mastery of graphic representation. The earlier students of children's drawings mark out three distinct periods in the growth of the normal child. Burk,[1] for example, states that:

> "The progress of a child learning to draw is roughly divisible into three periods.
>
> "1. A period in which the movements are wholly muscular and are unguided by the visual centers in any degree; roughly, this period is that of the second and third years.
>
> "2. A period roughly between the fourth

[1] Burk, The Genetic versus the Logical Order in Drawing, 1902, p. 321.

year and the ninth or tenth, characterized by the first beginning of crude representation and slowly proceeding toward an interest to accurate drawing of objects as they are actually seen.

"3. A period beginning with an interest in accurate representation of what the eye sees to the exclusion of associated ideas."

The more recent analytical and biographical studies render it possible to characterize the development of drawing in greater detail. Both objective and subjective standards determine the delimitation of the individual developmental periods. The objective point of view dominates the following differentiation. (After Kerschensteiner and Meumann.)

1. *Pre-experimental Stage.* The separate parts of the objects drawn are merely placed side by side. The little drawer represents his father or mother by placing the principal parts of their bodies side by side. The child does not really draw; he tells, describes, counts up what he knows. He has grasped the idea of graphical expression and seeks for a new form of expression and communication. This stage extends nearly to the fourth year.

2. *Stage of the Schema.* The drawing is schematic. The child's outlines of animals and various objects are not visual representations, but are symbolic reproductions of what the child knows. He does not attempt to show accurate details; is satisfied with rounding contours. The same or only slightly changed

schema serves for a man or a woman. The animal schema is a man laid horizontally, with four legs added. The laws of opacity, perspective, and space relations are not recognized. The child shows both exterior and interior of a house in the same drawing.

3. *Stage of Beginning Appreciation of Line and Form.* The child makes his first attempts at coherent visual representation, but the imitative appearance still contains schematic features. This stage begins about the seventh year with gifted drawers, much later with the untalented, or is never reached.

4. *Stage of Representation According to Appearance.* The schema disappears from the drawing. The form of the representation is determined by the appearance of the object. The drawing is in outline; it makes no attempt at the reproduction of tri-dimensional space. Beginning with the eleventh year, a conspicuous percentage of children cultivate a number of means of representation of depth and plasticity. This introduces the final stage.

5. *Stage of Representation According to Tridimensional Form.* The depth and plasticity of objects are now shown by means of proper regulation of light and shade, perspective, and foreshortening. This is the final stage, typical of the highest development of drawing. Many drawers do not reach this stage.

The subjective standards of delimitation are based upon the development of individual children. Luquet's biographical study indicates that

all individuals pass successively through four ages or phases of drawing.[1]

1. *Involuntary Drawing.* The child has perceived that the drawings of others represent objects and that he is able to trace lines for himself. He does not realize, however, that he can represent similarly with his own lines. He notes the accidental similarity of his drawings after he has made them and then calls attention to "his" drawing. It is not yet an intentional creation.

2. *Synthetic Incapacity.* The child determines to represent the visual appearance of objects. From then on he varies only in his manner of expressing realism. In this stage he is overcome by diverse obstacles, the chief of which is his synthetic incapacity to assemble the different details which have gained his attention into a coherent whole.

3. *Logical Realism.* This age is characterized by logical realism. The child deliberately attempts to reproduce not only what he is able to see of an object, but all there is. He gives a typical form to each part.

4. *Visual Realism.* In this stage the child arrives at visual representation, submitting with more or less lack of skill in execution to the principles of perspective. He has arrived, as far as drawing is concerned, to the period of the adult.

The stages of graphic development are not a result of a completely independent development

[1] Luquet, Op. cit., p. 225.

of the child; imitation and teaching must be taken into consideration as adding or even interfering with the natural gifts. It is very possible to delimit stages which show the degree of conformity to the ideals of instruction.[1] Thorndike[2] has constructed a scale which attempts to measure a child's achievement in drawing. The scale is composed of fourteen typical drawings taken from Kerschensteiner's *Die Entwickelung der Zeichnerischen Begabung.* The fourteen sample drawings range in merit by approximately equal steps from 0 up to 17. The drawings of a child or of a class may be compared to the sample drawings of the scale and the degree of achievement estimated accordingly.

Becterew[3] gives a list of ten objective characteristics by which children's drawings may be judged. The list includes such factors as the degree of regularity of lines, relative complexity, degree of imitation, time required for observation, coherence of related events, completeness of execution, creative power, permanent and temporary individual peculiarities.

Whatever pedagogical values are derived from an analysis of the stages of drawing must take

[1] See Stiehler, Psychologie und Methodik des Zeichenunterrichts, pp. 18–21.

[2] Thorndike, The Measurement of Achievement in Drawing, 1913.

[3] Becterew, Objektive Psychologie, 1913, p. 392.

into consideration the individual child as well as the group. The individual child not only is likely to differ markedly from other children of his own age, but is variable in his own development. Periods of regress to former stages are frequent. Old schemas which have been discarded in favor of visual representation reappear for extended periods of time. The situation is further complicated by the common appearance of mixed stages in which the drawings of the child have characteristics from both earlier and later stages. Disposition, mood, and physiological condition affect the type of drawing. If interested and animated, the child uses one type of representation; if distrait or fatigued, another type. The calm, logical, positive child draws more exactly and talks less; the brilliant, imaginative child sketches freely and supplies the details orally.[1] As Luquet[2] says:

> "The theoretical distinction which we have indicated among the four ages of drawing is, in fact, much less sharp; each period is prolonged after the following period has commenced; in particular, not only with the child, but equally with the adult, more or less sporadic traces of logical realism persist in the drawings of individuals who have arrived consciously to the phase of visual realism."

[1] Rouma, Op. cit., p. 134.

[2] Luquet, Op. cit., p. 228.

III. Drawing as a Form of Language.

The statement that "drawing is not an art for children, but a language"[1] is found in some form in practically every work on children's drawings. The earlier studies as usual give more attention to groups than to individuals. The following frequently quoted comparison is from Lukens:[2]

> "The development of drawing should show the same stages as the development of speech —suggested as follows:

Speech	*Drawing.*
1. Automatic cries and reflex or impulsive sounds.	1. Automatic and aimless scribble.
2. Imitation of sound, but without meaning; child babbles back when addressed.	2. Scribbling localizations and imitation of movements of other persons' hands.
3. Understands words, but does not speak beyond such words as "mama," "papa," etc.	3. Understands pictures, but does not draw beyond the simplest localization of features by scribbling.
4. Repeats words as mere sounds when they are said to him.	4. Copies from others to see how to get the right effects in the use of lines.
5. Uses words to express his thoughts.	5. Picture-writing, illustrated stories, scenes, etc.
6. Studies grammar and rhetoric.	6. Studies technique of drawing, perspective, proportion, shading, etc.

[1] Levinstein, Kinderzeichnungen, 1905.

[2] Lukens, A Study of Children's Drawings in the Earlier Years, 1896.

It is undoubtedly true that the first two stages mentioned above have a common basis in the impulses of play and imitation. From this point on the comparison loses its significance, because the characteristics given to the last four stages of drawing are not typical of its genetic development. The biographical studies of Luquet[1] show that during this period the development of drawing is characterized by the method of "expressing realism." Language, on the other hand, tends to become more and more abstract.[2] The child's free drawing is always individualistic, while his language is dominated by social convention. In the earlier stages there are many parallels between the two forms of expression. In the later stages drawing diverges in one direction toward the concrete, while language diverges in another toward the abstract. This may be illustrated by reference to studies in the racial development of drawing.

Haddon's[3] biological study of the evolution of drawing shows that:

> "There are certain needs of man which appear to have constrained him to artistic effort; these may conveniently be grouped under the four terms of Art, Information, Wealth, and Religion.

[1] See previous section.

[2] Meumann, Experimentelle Pädagogik, II, p. 693.

[3] Haddon, Evolution in Art, 1914.

"*Art.*—Aesthetics is the study or practice of art for art's sake, for the sensuous pleasure of form, line, and color.

"*Information.*—In order to convey information from one man to another, when oral or gesture language is impossible, recourse must be had to pictorial signs of one form or another."

Here it is seen that drawing serves as a language when its chief purpose is primarily to convey information. Let us note what happens in the development of pictorial signs as a form of language. Haddon[3] gives the following stages:

1. *Pictographs.* Pictures or actual representations of objects.
2. *Ideograms.* Pictorial symbols, which are used to suggest objects or abstract ideas.
   Phonograms. Graphic symbols of sounds.
3. *Verbal Signs*, representing entire words.
4. *Syllabic Signs*, which stand for the articulations of which words are composed.
5. *Alphabetic Signs* or *Letters*, which represent the elementary sounds into which the syllable can be resolved.

The development proceeds from the individual and concrete to the conventional and abstract. The pictograph is the individual's own representation of the salient features of some object; the ideogram and the phonogram still carry something of visual appearance, but have become conventionalized by social repetition, while verbal, syllabic, and alphabetical signs have lost all

semblance of visual representation. "The less the picture became like what it was intended to represent, the more useful it became as a means for conveying thought."[1]

Contrast with this the development of the child's drawing in our present social organization. (After Luquet and Kerschensteiner.)

1. *Synthetic Incapacity.* Graphic juxtaposition of what the child knows.
2. *Schemata.* Symbolic representation of what the child knows. Conventionalized and generic.
3. *Visual Coherence.* Imitates individual appearance, but contains schematic features.
4. *Two-dimensional Representation.* Visual representation which lacks perspective.
5. *Visual Realism.* Perfect visual representation of the individual object.

The entire trend of drawing as representation is from the general and abstract toward the specific and concrete, just the opposite from the development of drawing as a form of language. It is evident from the above that drawing is most like language at the second stage, when symbolic or generic drawings are the rule. Luquet[2] questions the advantage of the achievement of artificial education in substituting visual for logical realism

[1] Haddon, Op. cit., p. 221.
[2] Luquet, Les Dessins d'un Enfant, p. 247.

in drawing. The drawing which permits the exhibition of a series of facts in a condensed theater of action deserves serious consideration before being discouraged.

It is undoubtedly true that the emphasis of our education upon the visual in drawing has discouraged children from continuing their efforts at logical drawing. It remains only in the incidental construction of the analytical drawing. It is here that drawing continues to parallel language. Analytical drawing is characterized by logical and generic representation. This fact is of importance to our consideration of laboratory procedure; it suggests why analytical drawing and description are relatively interchangeable and why either of these devices is preferable to representative drawing.

Drawing presents its parallels to language before it yields to the domination of visual reality. Rouma[1] has made a detailed study of this early period of the child's life with reference to the drawing-language. He describes four general tendencies which, with considerable individual variation and complexity, appear in chronological order. A summary follows:

1. *Indicative Tendency.* The child makes a mark and indicates orally what it means. Each sign stands for some unit in the total drawing.

[1] Rouma, Le Langage Graphique, pp. 131–154.

The child draws a man and as she marks says, "This is the nose," "Here is the mouth," etc. Visual representation is entirely lacking in the pure type. The lines do not exteriorize, but seem to fix the characteristics in the mind of the child.

2. *Descriptive Tendency.* Visual representation enters into the drawings. The general form is greatly simplified, but fairly exact and the parts are relatively in proper position. The representation is semi-ideographic and shows in a descriptive way what the child knows about the object.

3. *Narrative Tendency.* The child draws a number of diverse characters and representations which he unites into a story by oral comment. The drawings are partially indicative, but the child comprehends their representative value. In the earlier stages of this tendency oral statement plays the leading part; later it is used only to unite the various scenes of the story. The drawings are general in character, the details being expressed orally. The individual drawings frequently are distinguished by a single characteristic attitude. The drawings seem to exteriorize the story and facilitate the narrative.

4. *The Drawing-Language at Its Height.* Better technique and more sustained attention favor the composition of scenes. The child becomes animated. He speaks in a high voice. He completes the imperfections of his drawing orally, by gesture, by facial expression. His characters speak, move, have life. The individual lines have greater representative value,

but there is a distinct tendency to simplify the drawing as a whole. The non-useful details are reduced, while the characteristic feature is frequently exaggerated. The child tends to conventionalize his drawings by progressive simplification when he uses the same characters in successive scenes.

Chapter V

STUDIES IN THE ANALYSIS OF THE DRAWING ACT

The analysis of the drawing product given in the preceding chapter calls attention to individual variations in the drawing ability, but fails to explain the causes of difference. The present chapter gives a review of the results of recent attempts to make such an explanation upon the basis of an experimental analysis of the drawing activity.

I. *Analysis of the Act of Drawing* (*Albien*[1]).

The complete act of drawing is composed of two major processes which are quite distinct. It consists of an optical-perceptual process and a motor-graphic part, each of which is composed of subordinate partial processes. In the optical-perceptual process the eye receives the sensory stimuli from the object in view and the mind assimilates the perceived impression on the basis of previously acquired experience with similar sensory material. In the motor-graphic process the hand is set in motion to reproduce the perceived and more or less worked over visual image of the original object. The partial processes which enter into the optical-perceptual part of

[1] Albien, Behalten und Wiedergabe einfacher Formen, 1907.

the drawing activity show the following characteristics:

1. *Purely Optical Process.* This includes the fixation of the eye upon the object and the imaging of the object upon the retina.

2. *Sensational Process.* This embraces the passive taking in of the specially disposed sensations of brightness, color, surface distributions, etc. It may also include the sensations of accompanying eye and hand movements.

3. *Awakening of Percepts Which Tend to be Present and Apperception.* The previously acquired percepts of similar sensation complexes which are at hand become actual. The object is grasped in consciousness, recognized, identified, and interpreted as the *particular* object present.

4. *Assimilation.* These apperceived ideas (3) assimilate immediately with the passively taken in impressions (2), causing them to become active in consciousness.

5. *Secondary Reproduction of Earlier Associations.* Reproductions of formerly acquired concepts and judgments of similar appearing objects enter the mind. The conceptual activity deviates somewhat from the object present and other ideas enter the mind and assimilate with the objective impression. These related ideas may fuse unconsciously into our interpretation of the perceived object, or they may assume a free relation which leads to reflection by contrast and com-

parison and ultimately to our highest understanding of the object.

6. *Preconceived Observation.* The five partial processes just defined are all modified by the original purpose of the observation of the object. If the purpose is to make a complete and thorough examination of the object, the activity of each of the elemental processes will be markedly different than if the making of a mere sketch be in mind. Through the preconceived purpose the whole process of perception is given a particular direction, while from the countless number of possible concepts which rise in consciousness a definite selection is made. Attention directs itself predominantly to that in the object which is in accord with our purpose, whether we are conscious of its deviation or not.[1]

Such are the partial processes of the optical-perceptual part of the drawing act. Similarly, the motor-graphical part of drawing is composed of subordinate elements. The hand is controlled by three chief factors.

1. *Direction by the Optical Image.* When the drawer looks away from the object of observation (and always, of course, when he is drawing from memory), his hand is guided more or less by the visual image which is retained in memory. This is, moreover, always an inwardly worked

[1] Judd and Cowling, Studies in Perceptual Development, Psychological Review, 1897.

over image, subject to the influence of any one or all of the optical-perceptual partial processes. Some drawers examine the object carefully for several moments, study it more or less analytically, then draw from the retained image without further looking at the object. Other drawers revive their waning image by frequently recurring glances at the object.

2. *Kinesthetic Control.* The hand is controlled in its particular movements by the immediate kinesthetic sensations and by images of previous sensations. Previous experience in drawing similar lines gives the needed muscular control. The kinesthetic images of the eye or hand movements made during the period of observation may also share in the subjective control of the hand.

3. *Control by Watching Results.* The appearance of the developing drawing is used as a means for conscious comparison with the appearance of the original object. The wayward lines are corrected or directed accordingly.

It is important to note, as Albien has emphasized, that the preceding optical-perceptual process of drawing varies individually in its composition, its components, and the significance for the whole process. With one individual analytical observation is partial and inexact. Another observes but few details, but observes these details minutely. One individual quickly gives over to the play of his secondary associations or reflec-

tions, while another adheres more closely to the given objective impressions and makes but little individual interpretation.

As with the individual behavior of the perceptual part of the act of drawing, so are the individual processes which control the hand. With one drawer the hand is guided more by the visual image, while with another it is guided by the assistance of the imagination or reflection. With one individual the hand follows point by point the exact analytical observation of the object. With another it follows the schema acquired from some similar object. Finally, with individuals of strong motor inclination, the motor images of the eye or hand movements may equal or for a time predominate over the visual image.

These general considerations of drawing which rest upon experimental analysis show that correctness and originality in the execution of drawing may depend upon extraordinarily varied factors. It now remains to discuss the manner in which these partial processes act together in different individuals. Individual drawers may be classified by the difficulties which they encounter in the act of graphic representation, or by the gifts which they possess for successful drawing.

II. *Perceptual Development* (*Judd and Cowling*[1]).

Judd and Cowling[2] find that subjects attempting to reproduce a simple figure after an exposure

[1] Op. cit.

[2] See Chapter II for method.

of ten seconds exhibit two types of perceptual development. One type gets an early mastery of the general form and a later mastery of the details. The second type begins immediately to master the details of the figure to the temporary neglect of the general form. This same experiment gives striking evidence of the complexity of the perceptual process and of the variations existing among different individuals. It is very significant that repeated exposures and continued analytical study is necessary before the perception of a simple figure is mastered. Correct temporary memory of one part of the figure becomes vague when attention is directed to another part.

III. Drawing Types (*Albien*[1]).

Albien's carefully conducted experiments[2] indicate that wide variations exist between individual drawers, who tend to approach more or less closely one of two sharply distinguished extreme types.

1. *Visual Type.* Appears in many gradations according to the share played by apperception. This type has a clear visual image and holds more to the direct objective impressions. There are two chief sub-types:

(a) The subject perceives a clear visual image, but permits apperception and associa-

[1] Op. cit.

[2] See Chapter II.

tion to enter little or not at all into activity. The image is therefore transitory. The subject may be a good copy drawer, but fails to draw well from memory.

(b) The subject has a clear visual image. He assimilates the impression and seeks through analysis and subsequent synthesis to make the impression conspicuous. This subject is a good drawer.

2. *Constructive Type.* The subject has a visual image which is but little imprinted. He depends upon reflection and subjective construction for the (memory) drawing. The original image is altered in the drawing. The success of the drawing depends upon the subject's mental power for correct association and reflection. If not accompanied by analytical observation, the drawing is a failure.

Samples of the above types may be shown by giving the reactions of several of the subjects of Albien's research.

1. *Extreme Visual Type.* Franz G., 9 years. Ranks 29 in a class of 49.

Very lively, enters into the experiment with great zeal. Attempts to draw a figure which has been exposed ten seconds with his eye held upon the fixation point in the center of the figure. Interesting to observe how he stops abruptly after the first stroke and draws no further. "The image has disapppeared." He draws with rapid, precise strokes. He observes

a figure at his leisure, then draws it from memory. Says, "The image hangs in my head." He retains the "whole image" very well. Numerous objects such as a barometer, vase, kaleidoscope, etc., are exposed for ten—fifteen—twenty-five seconds. Franz retains the characteristic form and draws it without reconstruction. Looks often in the distance while drawing. Subject is markedly visually gifted and does not help himself through construction.

2. *Constructive Type with Some Visual Endowment.* Paul T., 9 years. Ranks 5 in a class of 49.

Gives precise answers to all questions. "I cannot do that." "I do not see sufficiently for that." Thinks long before he begins to draw (up to two minutes); then draws slowly, but with rapid, precise strokes. For one memory drawing he observes 170 seconds; for the other two, relatively a short time. During the drawing from the model his eye wanders back and forth. During the study he makes automatic movements with the hand. Sees resemblances in the forms of the copy to objects with which he is familiar. He is an example of the construing type who helps himself considerably by his knowledge. He declares, "he marks how the lines and strokes lie." The drawings are good.

3. *Extreme Constructive Type.* Karl Sch., 15 years. First in general intelligence in a class of 43.

The performance of this pupil with good intelligence (first of forty-three) is poorer than that of many younger children with weak intelligence. In the drawing after fixed seeing he first gazes in the distance. One can see from the movements of the muscles of his eyes and forehead that he is meditating. Upon questioning he states that he is reflecting upon the relations. He does not succeed with the memory drawing; an argument that he has no visual image and that his mental power is unable to supply the deficiency through reflection. When he makes the drawing from the model he draws precisely and in a shorter time. Upon questioning he says that he forms the drawing by combination of the separate parts, reflects on the relations, and thinks of similar appearing objects. Makes four successive attempts to draw the same figure after ten-second exposures with eyes on a fixation point. Fails each time. The subject is of the constructive type with weak optical endowment.

Albien compared his subjects by means of tachistoscopical reading tests with Messmer's objective and subjective reading types.[1] He

Objective Type	*Subjective Type*
1. Rigid fixation.	1. Fluctuating attention.
2. Relatively small scope of attention.	2. Relatively large scope of attention.
3. Attention directed to periphery.	3. Attention directed to interior.
4. Objective fidelity.	4. Subjective interpretive tendency.

[1] Messmer, Zur Psychologie des Lesens bei Kindern und Erwachsenen.

announces marked similarities between the visual drawing type and Messmer's objective type, and between the constructive drawing type and Messmer's subjective type. The German word *kriegführenden* was exposed successively by means of a tachistoscope for a fraction of a second. The subjects endeavored to write the word, or as much of it as possible, immediately after each exposure. The results follow:

Paul E., Constructive Type.	*Franz G., Visual Type.*
–kriegführenden–	
1. kriegfördern	1. -g
2. kriegfähren	2. -r.g.-
3. kriegfördern	3. -für-
4. kriegfördern	4. -für.r-
5. kriegfärchen	5. kr.-fü-
6. kriegführen	6. kr-g-
7. kriegführen	7. -führ-en
8. kriegfärchen	8. h-g führ-k
9. kriegfnrchen	9. krieg-
10. kriegfürden	10. krieg-r
11. kriegfüreln	Thinks he can make nothing further out of it.
12. kriegfährnden	
13. kriegfarden	
14. kriegführen	
15. kriegführenden	

Albien insists that thorough observation does not depend upon objective exactitude alone, but rather upon the relation set up between the objectively given impression and the conceptual

assimilation which follows immediately. If the associations and ideas which come about by reflection crowd out or misconstrue the objective impressions, the resultant percept and eventual drawing will be faulty and untrue. Thus the pure constructive type gives himself over too soon to subjective interpretation without at first seeing clearly. The pure visual type permits his comprehension to be circumscribed by the objective characteristics of the object so that he fails to perceive it in the light of his previous knowledge. The best type of observation for purposes of drawing (or, as we shall emphasize later, for purposes of scientific interpretation) is based upon a proper union of objective seeing and subjective contemplation.

IV. Difficulties in Drawing (*Meumann*[1]).

A large share of present literature takes the common point of departure that difficulties in drawing arise from two causes. The poor drawer cannot see correctly, or he fails in skill of hand. Meumann calls attention to the fact that he has found individuals who possess excellent sight and great skill of hand who cannot draw. Meumann gave a number of experimental tests[2] to determine the causes of individual variation in drawing. He found many causes for poor drawing and a number of types of drawers.

[1] Meumann, Experimentelle Pädagogik.

[2] See Chapter II.

The "seeing" of most men who are not painters or drawers by occupation is in no manner an analyzing and discerning seeing.[1] The object of their seeing is not that of making themselves reliably trustworthy with the form and colors of objects, but at best only to recognize the things, to connect the objects with the words commonly used in naming them, or to learn to know with certainty the characteristics of things needful for the practical employments of life. Few realize how inaccurate is their knowledge of the form and color of the most familiar objects. Ask them to draw a postage stamp or the picture of a friend from memory, and they assert that they know the thing sufficiently, but cannot draw it. Challenge them then to describe the appearance of the stamp, and for the most part, to their surprise, they fail lamentably. What is the cause of these failures? This question may be best answered by presenting a list of the difficulties found in memory drawing.

It should be noted here that the memory is involved in drawing even when the object is in sight. The drawer must keep the mental image in mind at least while actually drawing. He, of course, keeps the mental image from disappearing or changing greatly by constant return to the object. Unless he can get the general outline of

[1] Meumann, Op. cit., p. 719.

the object fairly well imaged and retained in memory, he is very likely to have the not uncommon difficulty of being unable to make the detailed parts of his drawing fit into a uniform whole. The following difficulties come to light most clearly during attempts at memory drawing.

1. The will to see analytically has not been aroused. In the case of most drawers who have never received drawing instruction, the will for careful notation of the specific form and colors of things is not present.

2. In spite of the will to see analytically the drawer cannot make a correct analysis. He lacks the power of discrimination between the general setting and the minor details.

3. Defective visual memory images. The drawer has a deficient sense of form, particularly as to indistinctness and incompleteness. Despite exhaustive observation, he retains no definite visual memory of form, color, or space situations.

4. Lack of ability to hold the visual memory image in attention while drawing. When the drawer turns his attention to the act of drawing, the mental image becomes dim or disappears entirely.

5. Lack of co-ordination of the visual image with the execution of the drawing movements. The drawer cannot guide the hand according to the dictates of the visual image.

6. The memory image is disturbed by the sight of the beginning drawing and by the incongruity between this and the design existing in the imagination of the drawer. This is common with unpracticed drawers.

7. The lack of acquired drawing designs (schemata). The trained drawer acquires a mass of schemata by which he can produce a schema of an animal, a flower, or a house, quickly upon paper. This serves as a support for the representation of his memory images and he gradually modifies the schema until it corresponds to that which he would express. Many drawers who are deficient in schemata and can draw well from another drawing cannot draw from an object.

8. Lack of dexterity or skill of hand. The drawer is unable to make a straight or curved line satisfactorily.

9. Lack of knowledge of the projection of tridimensional space upon a flat surface.

10. Defective artistic sense interferes with the individualistic aesthetic treatment of drawing.

11. These defects may be found in different combinations in different individuals.[1]

V. Types of Retention (*Meumann*[2]).

Finally, we may examine certain types of retention in drawing. No two individuals are

[1] Meumann believes that 2, 3, 4, and 5 are defects of nature and that the others are due to training.

[2] Op. cit.

exactly alike, but it is possible as well as profitable to describe a number of characteristic types of retention in drawing. Whether we are interested in drawing from the aesthetic, the representative, or the scientific point of view, accurate knowledge of the type of retention of the pupil is of the greatest importance. The following analysis is based upon Meumann's experiments with eleven adults.[1]

1. The completedly untrained drawer. The subject has few drawing concepts and shows conspicuously that a certain knowledge of the pure technique of drawing, regardless of all endowment, is necessary. Some idea of the manner of representation is necessary before an actual "drawing" can be produced. The subject draws a pure schematic sketch and cannot represent otherwise. This type of drawing resembles that of many young children and that of primitive peoples.

2. The subject (drawing from memory) supports himself exclusively by the image of the object without supplementing this by additions according to his knowledge or conjecture. The drawing is incomplete, but rests upon absolutely pure visual retention.

3. Similar to the preceding type, save that the image is supported by knowledge and reflection.

[1] See Chapter II.

If the perspective course of the lines is not clear in the visual image, it is reconstructed in thought.

4. This type has such a weak visual memory that he yields completely to reflection and construction of the object.

5. The subject possesses numerous drawing schemata. He knows objects similar to the object and for the most part works with them. Thus he does not represent the individual characteristics of the original objects. His drawing technically is very complete. (It seems that professionally trained drawers incline to this type of retention.)

6. This type, like the child, gets a completed schema at once from the object. It is, however, generic, not specific. He draws a general cigar box, not the one before him.

7. The specifically artistic type. He characterizes his drawings through a habitual leaning to the artistic working of the object. He seeks upon this basis to get a certain aesthetic effect out of the object. This tendency may show itself in unskilled drawers and is relatively independent of skill of hand and acquired schemata.

8. Finally, is the subject who draws better from memory than after the model. He depends upon his numerous visual memory images. He has formed the habit of impressing himself with the

visual appearance, or he possesses that exceptional "adventitious retention" in high degree.

Karrenberg[1] found that children of nine and ten years of age under the influence of systematic training were enabled to double their ability in representative drawing.

[1] Karrenberg, Der Mensch als Zeichenobject, 1910.

PART III

EXPERIMENTS AND CONCLUSIONS

Chapter VI

THE EXPERIMENTS

Attention was called in Chapter I to the fact that laboratory work in science teaching has three aims: the observation of material, the making of records, and the retention of learning, and that it furthers these aims by three devices: representative drawing, description, and analytical drawing. The determination of the character of the various interrelations of these factors, and the psychological analysis of drawing were set as the problems for ultimate solution. The intervening survey of the literature of drawing has been devoted to the psychological setting of these two problems. The present chapter will present a series of special experiments which have been organized to complete the analysis of the various factors of laboratory teaching.

Experiment I. Representative Drawing, Description, and Diagrammatic Drawing.

1. *Problem.* To evaluate the correlation between ability in representative drawing and ability in description and diagrammatic drawing.

2. *Method of Procedure.* The special tests used for this problem were selected after numerous preliminary trials which were necessary to adjust

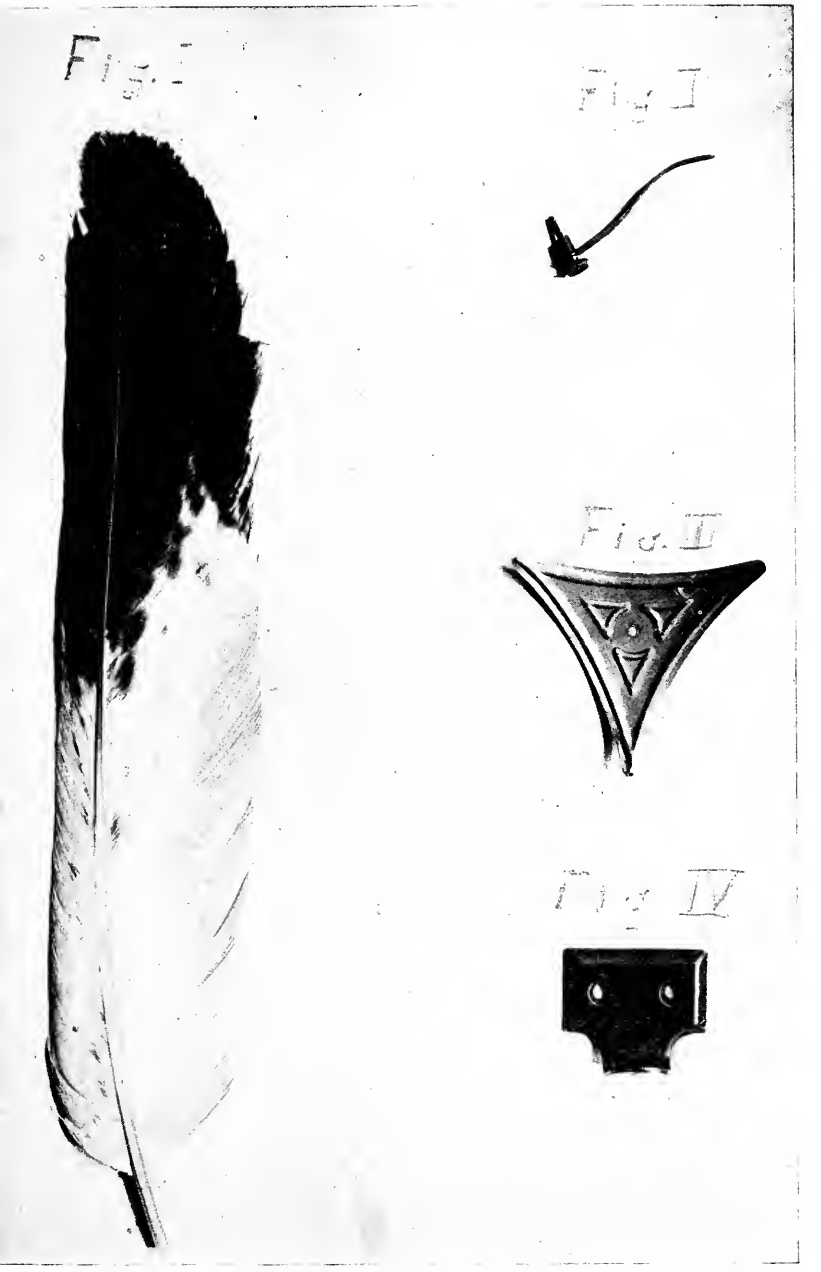
them to time limitations and to eliminate directions which were liable to misinterpretation. It was necessary to select objects for the various tests which were approximately equally well known to the different subjects, which afforded a range of difficulty adapted to grading, and which could be finished at a single sitting.

Test No. 1. Subjects. 51 students in a first-year high school class in General Science.

A turkey feather (see Figure 1) was selected for this test. It serves as a good object for drawing and description, while its finer structure is unknown and of sufficient intricacy to require a satisfactory amount of ingenuity for study and diagramming. Parts of the feather were mounted on microscopic slides and focused under a number of microscopes in such a way that the detail of the feather was equally manifest to each subject. The following preliminary statement was made to the class at the beginning of a regular laboratory period:

> "You will be given a test today to compare your abilities in drawing, description, diagramming, and laboratory analysis. The work will be counted as a regular day's work in elementary science, but, as different classes are to be compared, you are asked to do your best."

Each pupil was then given a feather, pencil, rubber, paper, and a sheet of directions for the first part of the test. At the end of the given



FIGURES I TO IV.

time the first records were collected and directions passed for the second part of the test. The four parts of the test were given in an eighty-minute period. All of the tests were given under my personal direction. The directions, which were given out one part at a time, follow:

Part I. Drawing. (Materials: eraser, pencil, and drawing paper.)

Write your name and the number of your feather at the top of the page of drawing paper.

Place the feather in position as directed and make a careful drawing of it. (Time allowed, 13 minutes.)

Part II. Description. (Materials: pen, ink, and ruled paper.)

Write your name and the number of the feather at the top of the page.

Without tearing or pulling the feather apart in any way, study it carefully and describe it so as to explain as much as possible about the feather to a person who had never seen one. (Time allowed, 12 minutes.)

Part III. Dissection and Analysis. (Materials: same as II.)

Write your name at the top of each page of paper used.

Pursue carefully the following directions and answer the questions as they appear. Do not write anything except the answers.

Examine the feather again and note that it is composed of a central axis or *quill* and an expanded, flattened part called the web or *vane.* The quill is divided into two parts: (a) the

hollow, rounded, transparent *barrel*, which is the end of the feather that is attached to the body of the bird, and which has no attached parts, and (b) the *shaft*, which has the vane attached to its sides. Examine the surface of the vane with a lens and note that it is composed of a series of side branches of the shaft which lie closely parallel to one another. These side branches are called *barbs*.

Question 1. In what direction do the barbs run with reference to the shaft? (Time allowed, 10 minutes.)

After having answered Question 1, tear one of the barbs loose from the barbs in front of and behind it. Observe that it is similar to the one which has been mounted for microscopical examination. Examine the mounted barb under the low power of the microscope and note that the barb has a long, narrow body with two opposite rows of small, more or less united, branches attached to it. These fine branches of the barbs are called *barbules*. Note that the barbules in the row on the upper side of the barb have a number of smaller branches or outgrowths, which gives the barbule something of a bushlike appearance. These smaller outgrowths are called *hooks*, because some of them have little hooks at the end. The barbules in the row on the lower side of the barb do not possess these smaller branches. Taking the feather as a whole, then, there are in turn a shaft with barbs on either side; each barb with a row of barbules on either side and every upper barbule with a number of hooks.

Question 2. If each of the barbules possessing hooks averaged 10 hooks each, how would you estimate the total number of hooks on a feather? (Time allowed, 10 minutes.)

Having answered Question 2, pull two barbs apart slowly and watch carefully what happens. Examine the prepared mount of a section of the vane, in which some of the barbs have been partly torn apart. Examine the torn part and other parts of the vane in this mount under the low power of the microscope. Note again that the upper row of barbules terminates in clusters of hooks, while the barbules running back into them from the barb just ahead do not have the hooked branches.

Question 3. Explain in detail how the barbs are held together. (Time allowed, 15 minutes.)

Part IV. Diagram. (Materials: eraser, pencil, and drawing paper.)

Write your name at the top of the page.

Make a diagram (several, if necessary) showing the relative arrangement of the shaft, the barbs, the barbules, and the hooks. Label it carefully. (Time allowed, 15 minutes.)

Test No. 2. Subjects.

Group 1: 48 university graduate students.

Group 2: 50 university undergraduate students.

Group 3: 30 university undergraduate students.

Group 4: 31 university undergraduate students.

Total, 159.

Test No. 2 is essentially a repetition of the parts of Test No. 1 which measure ability in represent-

ative drawing and description. The single variation is in the use of a different object for copy. Each member of Group 1 was given similar drawing materials and an object which was unfamiliar to his or her drawing and describing experience. The object was a small metal spring-clip (see Figure 2) taken from the stage of a compound microscope. The students were directed as follows:

> *Part I.* Write your name at the top of the page of drawing paper. Place the object in the exact position as directed and make a careful drawing of it. (Time allowed, 7 minutes.)
>
> *Part II.* Write your name at the top of the page of drawing paper. Make a careful written description of the object. (Time allowed, 7 minutes.)

The members of Groups 2, 3, and 4 followed similar directions, using different objects to copy. Each member of Groups 2 and 3 was given a flat, triangular, metallic object (see Figure 3) which will be referred to as the "triangle." Each member of Group 4 was given a small metallic sash-lift (see Figure 4). In every case one drawing and one description of the same object were made by each subject.

3. *Methods of Scoring.* As the validity of the correlation established between any two traits depends upon the accuracy of the original measurements, great care has been used to insure exact

scoring of the results of these experiments. Ten competent markers co-operated in scoring the various tests. They first became thoroughly familiar with the various tests by taking them. They were then carefully instructed in the system of grading, and means were taken to insure deliberate and painstaking work. It is believed that ten such judges are of greater value than a much larger number selected from a group of persons who are strange to the tests and more or less indifferent to the results. The procedure involved the ranking of the individual members of each group serially in order of the merit of their efforts. Thus it was necessary to discover which one of the 51 high school pupils was best in drawing, which one was second, and so on down to the poorest.

(a) *Method of Scoring Drawings.* Each drawing was compared directly with every other drawing of the same group. At each comparison the drawing which was superior was graded '1,' and the drawing which was inferior, '2.' When all had been compared, the marks for each drawing were summed and the total recorded. This was done by each of the ten markers and the final total recorded for each drawing. Thus each drawing in a group of 50 was compared with the other 49 by ten different judges and received a final mark on the basis of 490 individual compari-

sons. The drawing having the lowest total, i. e., the most grades of '1,' was ranked best; the one having the greatest total was ranked poorest, while the remaining drawings were ranked in between according to the size of their total score.

The markers were instructed not to grade "ties," but at each comparison to grade one superior and the other inferior. This was not productive of any considerable difficulty and insured the use of greater discrimination on the part of the judges. It was found convenient to tally according to the score-card shown on page 117. The score-card exhibited here was prepared for a group of 30 drawings. In scoring, the drawings in this case were numbered 1 to 30. Drawing No. 1 was scored by comparison with each of the other 29. At every comparison the two drawings concerned were scored '1' and '2' in the squares opposite their numbers on the tally sheet. Drawing No. 1, having been compared with the others, was then laid aside and No. 2 compared with the remaining 28. No. 3 was then compared with the remaining 27, and so on until none remained. Thus the score-card registers individual comparisons as well as totals and affords a complete record of all that was done. The score-card on page 118 shows the final rankings as given by the ten judges for this group.

Sample Score-Card of a Set of 30 Sash Lifter Drawings

Graded by L. N.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total	Rank
1		2	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31	3
2	1		1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	30	2
3	2	2		2	2	2	2	2	2	1	2	2	1	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1	2	2	53	25
4	2	2	1		2	2	2	2	1	2	1	2	2	1	2	2	2	2	2	2	2	2	2	1	1	2	1	1	2	2	49	22
5	2	2	1	1		2	2	2	1	2	1	2	2	1	2	2	2	2	2	2	2	2	2	1	1	1	1	1	2	2	48	21
6	2	2	1	1	1		1	1	1	2	1	2	1	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	35	7
7	2	2	1	1	1	2		2	1	2	2	1	2	2	2	2	2	2	1	2	1	2	1	1	1	1	1	1	2	2	45	16
8	2	2	1	1	1	2	1		1	2	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	34	5
9	2	2	1	2	2	2	2	2		2	1	2	2	1	2	2	2	2	2	2	2	2	2	2	1	1	1	1	2	2	51	24
10	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29	1
11	2	2	2	2	2	2	2	2	2	2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	58	30
12	2	2	1	1	1	1	1	2	1	2	1		1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	34	6
13	2	2	1	1	1	2	1	2	1	2	1	2		1	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	39	10
14	2	2	2	2	2	2	2	2	2	2	1	2	2		2	2	2	2	2	2	2	2	2	2	1	2	1	1	2	2	54	26
15	2	2	1	1	1	1	1	2	1	2	1	2	1	1		2	2	1	1	1	2	1	1	1	1	1	1	1	1	1	37	9
16	2	2	1	1	1	2	1	2	1	2	1	2	1	1	1		2	1	1	1	1	1	1	1	1	1	1	1	1	1	36	8
17	2	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	32	4
18	2	2	1	1	1	2	1	2	1	2	1	2	2	1	2	2	2		1	1	1	2	1	1	1	2	1	1	1	1	41	12
19	2	2	1	1	1	2	1	2	1	2	1	2	2	1	2	2	2	2		1	1	2	1	1	1	1	1	1	1	1	41	13
20	2	2	1	1	1	2	2	2	1	2	1	2	2	1	2	2	2	2	2		2	2	1	1	1	1	1	1	1	2	45	17
21	2	2	1	1	1	2	1	2	1	2	1	2	2	1	1	2	2	2	2	1		2	1	1	1	1	1	1	1	2	42	15
22	2	2	1	1	1	2	2	2	1	2	1	2	2	1	2	2	2	1	1	1	1		1	1	1	1	1	1	1	1	40	11
23	2	2	1	1	1	2	1	2	1	2	1	2	2	1	2	2	2	2	2	2	2	2		1	1	2	1	1	2	2	47	20
24	2	2	1	2	2	2	2	2	1	2	1	2	2	1	2	2	2	2	2	2	2	2	2		1	2	1	1	2	2	51	23
25	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2		2	2	1	2	2	56	28
26	2	2	1	1	2	2	2	2	2	2	1	2	2	1	2	2	2	1	2	2	2	2	1	1	1		1	1	1	2	47	18
27	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2		1	2	2	55	27
28	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		2	2	57	29
29	2	2	1	2	1	2	1	2	1	2	1	2	2	1	2	2	2	2	2	2	2	1	1	1	2	1	1			2	47	19
30	2	2	1	1	1	2	1	2	1	2	1	2	1	1	2	2	2	2	2	1	1	2	1	1	1	1	1	1	1		41	14

SAMPLE OF FINAL SCORE FOR A SET OF 30 SASH LIFTER DRAWINGS

No.	TA	KO	SM	PS	LH	HM	LN	HN	AC	AA	Total Points	Final Rank
1	31	35	32	38	36	39	32	33	37	38	351	6
2	30	35	37	38	35	35	36	36	37	31	350	5
3	53	43	30	37	34	45	51	43	32	36	404	11
4	49	48	54	50	45	50	49	46	50	53	494	23
5	48	49	45	55	48	38	46	39	54	48	470	19
6	35	31	30	35	36	34	31	35	34	32	343	4
7	45	49	56	55	49	40	54	55	41	46	490	22
8	34	31	34	41	30	29	33	30	33	40	334	3
9	51	51	50	47	44	45	46	45	50	50	479	20
10	29	35	37	36	33	42	34	36	41	30	353	7
11	58	58	58	58	58	58	58	58	58	58	580	30
12	34	33	44	33	33	33	43	34	34	36	361	8
13	39	40	47	46	43	36	40	37	45	46	419	14
14	54	55	49	48	53	50	50	54	53	49	515	26
15	37	38	39	41	46	43	42	45	39	38	408	12
16	36	32	34	30	33	30	33	31	31	35	325	1
17	32	41	43	39	41	37	33	40	42	40	388	10
18	41	40	36	36	37	42	35	39	41	37	384	9
19	41	46	46	45	47	51	50	45	46	42	459	17
20	45	42	38	32	50	51	49	33	39	54	437	16
21	42	42	41	42	39	40	40	41	41	41	409	13
22	40	41	46	36	50	43	45	37	49	41	428	15
23	47	52	42	54	38	49	51	53	39	43	468	18
24	51	48	53	51	54	54	53	49	52	53	518	27
25	56	50	55	54	54	53	51	54	55	54	536	28
26	47	29	31	29	29	31	30	46	30	30	332	2
27	55	56	55	55	54	51	54	55	52	55	542	29
28	57	55	42	47	44	54	54	45	43	56	497	24
29	47	51	51	50	50	56	51	48	55	50	509	25
30	41	48	50	47	51	55	48	54	50	42	486	21

(b) *Method of Scoring Descriptions.* The descriptions were graded by the method of counting points which is ordinarily used in scoring *Aussage* tests. In this instance each point was weighted by the judge according to its clearness of meaning on a basis of "10" for "perfectly definite." A score of 12-98 indicates that the pupil has given 12 points of description with sufficient clearness of statement to total 98. The descriptions were then ranked according to total scores. Where ties occurred the method of intermediate ranking was used; thus, a tie at 22 and 23 was ranked 22.5.

Each judge read all of the descriptions of a group before beginning to score. Each paper was then given a second preliminary reading, after which it was read a third time and scored by points. The final marks were determined by averaging the rankings of the ten judges.

(c) *Method of Scoring Diagrams.* The 51 diagrams of the structure of a feather were scored on the basis of a system of weighted points. One of the judges first ranked the diagrams serially according to the merit of their general appearance. To test the reliability of this ranking, a list of all the points which could be shown in a complete diagram of the feather was prepared. A second judge then ranked the diagrams according to the total number of points exhibited. The ranking which had been made upon the basis of general

appearance was now compared with the ranking which had been made upon the basis of the number of structural points shown. The two rankings were approximately, but not exactly, similar. The discrepancies were taken into account and a new system of weighted points arranged which made allowance for the difficulty as well as the number of the points shown in the diagram. The list follows:

STANDARD FOR MEASURING QUALITY OF DIAGRAMS

Characteristics Shown	*Credit*
1. Barbs attached to one side of shaft	1 point
2. Barbs attached to both sides of shaft	½ "
3. Barbs shown parallel	½ "
4. Barbs shown at a slant to shaft	½ "
5. Barbs attached to all parts of shaft	1 "
6. Barbules attached to one side of barb	1 "
7. Barbules attached to both sides of barb	½ "
8. Barbules shown parallel	½ "
9. Barbules at proper slant	½ "
10. Two distinct kinds of barbules	1 "
11. Barbules intermingled	1 "
12. Barbules attached to all parts of barb	1 "
13. Hooks attached to barbule	1 "
14. Several hooks on one barbule	½ "
15. Hooks on upper row only	1 "
16. Hooks hooking over barbules at a slant	1 "
17. Hooks on entire margin of row of barbules	1 "
Total possible score	13½ points

Points labeled insufficiently are given one-half credit. Points labeled incorrectly are graded 0.

Attention is called to the fact that the standard is not used to measure ability in representative drawing. In fact, the diagrams for the most part look very little like the original feather. It is, in reality, a measure of analytical observation, for the diagram called for is an excellent example of what is described in the first chapter as "analytical drawing." The pupil must have made the preliminary scientific analysis called for in the test directions before he can construct a successful diagram. As the particular test used requires a wide range of discrimination and considerable ingenuity in figuring out the structural plan of the feather, it serves most excellently for comparing the pupil's ability in analytical drawing with his ability in representative drawing.

4. *Method of Determining Correlation.* The presence of correlation signifies that some definite causal relation exists between two series or groups of data. The mere fact that two coexisting conditions vary in the same direction does not imply true correlation unless one condition is the cause of the other or both are due to a third cause. But if it can be shown that there are common factors possible to two variables, a tendency, however small, for the variables to fluctuate constantly in the same or opposite directions may be taken as proof of an actual correlation. Thus the determination of a small degree of correlation between

any two traits or achievements of a group of school children at once assumes significance, because there is no question about the common factors of intelligence and training. The important problem in this event is the elimination of all possibility of error in the method of finding the degree of correlation.

(1) *Correlation by the Rank Method.* The most practicable method of determining correlation between abilities for which there is no standard scale of measurement is by the rank method. When the same group has been ranked in two abilities in the manner described above, the results offer data for direct comparison. Column A, Table V, shows how the 51 high school students (see Test No. 1) stood when ranked in order of ability in description. The pupil ranked 1 was best in description; No. 2 was second best; and so on down to No. 51, who was the poorest of the entire group. Column B shows the order of merit of the same group in drawing.

By thus arranging the individual describers in a column in order, 1 to 51, and placing directly opposite the rank each received in drawing, we can get a general idea of the comparative ranking of the students in the two different abilities. Save in extreme cases, such casual comparison of the two columns will not be sufficient to ascertain satisfactorily the degree of correlation which may

TABLE V

Comparison of Abilities in Drawing and Description of 51 High School Pupils

	A	B	C		A	B	C
Name	Rank in Description	Rank in Drawing	*D* or Difference in Rank	Name	Rank in Description	Rank in Drawing	*D* or Difference in Rank
				(Continued from below)			
Brock	1	36	35	Pierce	27	15	12
Angel	2	38	36	Stone	28	47	19
Klein	3	30	27	Furth	29	21	8
Rose	4	19	15	Logan	30	22	8
Bean	5	26	21	Sully	31	20	11
Moraw	6	42	36	Hagen	32	6	26
Henry	7	24	17	Vander	33	44	11
Glass	8	11	3	Cook	34	16	18
Mathew	9	39	30	Virden	35	25	10
Greve	10	37	27	Lee	36	8	28
Lawler	11	49	38	Ames	37	51	14
Cooper	12	3	9	Lovel	38	9	29
Willet	13	35	22	Gamble	39	46	7
Hogan	14	41	27	Jack	40	50	10
Bolte	15	5	10	Tipton	41	18	23
Wilson	16	33	17	Cutler	42	28	14
Keen	17	12	5	Adler	43	1	42
Heck	18	43	25	Hill	44	31	13
Foster	19	27	8	Jacob	45	45	0
Ansorg	20	17	3	Atty	46	7	39
McKinn	21	32	11	Agar	47	23	24
Leap	22	48	26	Knapp	48	13	35
Runs	23	40	17	Weber	49	29	20
Donald	24	10	14	Ingle	50	4	46
Donker	25	34	9	Cole	51	14	37
Joseph	26	2	24				
(Continued above)							51)1016

Average Rank Difference or *Av. D.* equals 19.9

Chance D. equals 17

$r = -.271$ $\quad$ P.E.$_r$ = .09 $\quad$ $R = -.172$

be present. A number of significant possibilities lie bound up in data of this nature and the true one may be discovered only by careful study.

(a) *First Possibility.* The more ability a person has in drawing, the more he has in description. Then in a given test, barring errors in grading, the student ranking 1 in drawing ranks 1 in description; No. 2 in drawing is 2 in description; and so on through the series. Such a correspondence is signified by saying that the correlation equals 1 or 100% positive. Such a correlation exists between the volume and the weight of water. The merest glance at Table V shows that such a correlation does not exist between abilities in drawing and description. No. 1 in description is 36 in drawing.

(b) *Second Possibility.* The more ability a person has in drawing, the less he has in description. No. 1 in drawing would in this case be 51 in description; No. 2 in drawing would be 50 in description; and the others similarly related. This type of correlation is said to be —1 or —100% negative. Such a correlation exists between the volume and the amount of pressure exerted by a given weight of gas. It plainly does not exist in Table V.

(c) *Third Possibility.* The abilities in the two traits are in no way related, the obtained results occurring by mere chance. Such a result would

be obtained, for instance, if the papers were graded as they happened to lie in order in the pile without reference to their contents. Results indicating such a relationship are expressed by saying that the correlation is indifferent or equal to 0. The factor of chance correlation is particularly significant when dealing with small groups and in any case must always be discounted before a seeming correlation can be used as a basis for proof or inference. It will be necessary to examine our results more closely to determine if an indifferent correlation is present.

(d) *Fourth Possibility.* There is a tendency more or less pronounced for those good in drawing to be good in description, or, on the contrary, for those good in drawing to be poor in description. Such a tendency, depending upon its strength, manifests itself by a certain proportion of one group being good, or bad, as the case may be, in the other. According to the strength of the tendency it approaches plus 1, or +100%, if positive, or minus 1, or —100%, if negative. A complete analysis of the results obtained in this experiment will be necessary to detect partial correlation.

(e) *Fifth Possibility.* A certain selected part of one group is correlated with a certain part of the other group, while the rest of the group is indifferently correlated. Thus the best ten in drawing

may be very good in description, with all of the others in the group scattering. This type of correlation cannot be expressed by a simple coefficient, but must be shown by tabulations or graphs of the entire series. The results of this experiment give no evidence of this type of correlation.

It is evident that such terms as *good*, *poor*, *fair*, etc., secured from a brief inspection of comparative data do not indicate the amount of correlation with sufficient accuracy for scientific purposes. We have, therefore, resorted to more accurate methods of determining correlation.

(2) *Theory of Correlation.* The fundamental factor in correlation, as shown by the rank method, is the relative position of the same individual in two series of rankings. For instance, Glass (see Table V), who ranks 11 out of 51 in drawing ability and 8 in description, differs in relative position by only 3 points, which indicates a high positive correlation. Adler, however, who is first in drawing, ranks 43 in description, differing in position by 42 points, which indicates a negative correlation.

The rank differences, 3 and 42, are designated *D*, and serve as an indication of the tendency of correlation. A single *D* in a series of 51 *D's* indicates but little, for it may be due entirely to chance, just as the man who is first in wealth

among 51 may by pure chance be either second or forty-third in weight. If, however, we obtain the average of the 51 rank differences, we shall have a figure which measures the degree of correlation present. This measure is the *Average Rank Difference*, or, more simply, the *Average D*. In this series (see Table V, column C) the *Average D* is 19.9.

The *Average D* due to pure chance is equal to one-third of the number of subjects in a series, in this case one-third of 51, or 17. This average is called the *Chance D*. It means that if a pupil's *D* is less than 17, it is likely that there is some common factor which favors positive correlation; if the pupil's *D* is more than 17, it is probable that there is a common factor interfering with positive correlation and producing a negative correlation. If now we contrast the *Average D* obtained for the 51 pupils, 19.9, with the *Chance D*, 17, we must conclude that within this group there is a tendency for ability in drawing to interfere with ability in description. The degree of correlation is indicated by the amount of difference between the *Chance D* and the *Average D*, in this case 17 — 19.9, or —2.9. This sum is not large enough to be particularly significant with as few as 51 subjects. As a matter of fact, it is reduced by the results of the other series. For a rapid and accurate method of ascertaining the presence of correlation in a series of pairings approximating 50, the author recom-

mends the foregoing method. Reduced to formulae, we have the following:

Average $D = \frac{S(D)}{n}$; *Chance* $D = \frac{n}{3}$; in which S is the symbol for summation, D is the numerical difference between each corresponding pair of ranks, and n is the number of pairs. If the *Average* D is found to be within the range of $\frac{n}{3} \pm 2$, there is no evidence of significant correlation.

To find the numerical value of the correlation, the following formula may be used:

$$"R" = 1 - \frac{3S(D)}{n^2}$$

This quantity should be doubled if negative, which will obviate Lehman and Pederson's criticism given to Spearman's "Foot-Rule" method. This formula will give almost identically the same results as Spearman's:

$$R = 1 - \frac{6S(g)}{n^2 - 1}$$

in which g equals the numerical gain in rank of those individuals who made a gain in the second series over the first.

Correlation may also be computed by the "Pearson Method Adapted to Rank Differences," which gives more weight to the large D's. The formula, in which r is the degree of correlation, is:

$$r = 1 - \frac{6S(D^2)}{n(n^2 - 1)}$$

Provision is made for variation due to chance by use of the formula:

$$\text{P.E.}_r = .7063 \frac{(1-n^2)}{\sqrt{n}}$$

If r is no greater than P.E., there is no indication whatever of correlation. If r is greater than 3 P.E., the chances are 16 to 1 that an actual correlation exists.

The correlations obtained by both the Spearman and Pearson methods are given in the following results. The variations between them are without particular significance for these experiments.

5. *Results and Conclusions.*

(a) *Correlation between Drawing and Description.* The individual positions of the 51 high school pupils, and the group correlation between abilities in drawing and description are exhibited in Table V. Tables VI and VII show similar data for the group of 48 graduate students. Table VI shows the description in serial arrangement with the corresponding ranks in drawing. Table VII compares the descriptions to the drawings in serial order. Tables VIII and IX exhibit the correlations of the three remaining groups of students.

TABLE VI

Comparison of Abilities in Drawing and Description

48 Adult Students

	A	B	C		A	B	C
Name	Rank in Description	Rank in Drawing	*D* or Difference in Rank	Name	Rank in Description	Rank in Drawing	*D* or Difference in Rank
				(Continued from below)			
Cragun	1	7	6	Cano	25	41	16
Russ	2	32	30	M'C'mb	26	8	18
Hughes	3	18	15	Shield	27	15	12
Hosmer	4	6	2	Butler	28	44	16
White	5	20	15	Colpit	29	12	17
Carr	6	16	10	Ferry	30	46	16
Geilen	7	27	20	Cato	31	29	2
George	8	36	28	Weber	32	11	21
Ganard	9	22	13	Mitch	33	2	31
Wagner	10	25	15	Coward	34	23	11
Hubb	11	9	2	Harmon	35	5	30
M'Cann	12	35	23	Smith	36	14	22
Dohert	13	10	3	Whitem	37	28	9
Brown	14	19	5	Allen	38	33	5
Heig	15	39	24	Jenn	39	24	15
Boden	16	1	15	Kenn	40	48	8
Duffy	17	40	23	Yarbo	41	45	4
Hope	18	3	15	Hutch	42	31	11
Buch	19	42	23	Donson	43	4	39
Moss	20	38	18	Zeller	44	47	3
Kerst	21	13	8	Thomas	45	30	15
Rhodes	22	26	4	Vogel	46	37	9
Burg	23	17	6	Cowan	47	34	13
Snod	24	43	19	Porter	48	21	27
	(Continued above)						48)712

Average Rank Difference = 14.9

Chance Rank Difference = 16.

$r = .228$ P.E.$_r = .09$ $R = .079$

Table VII

Comparison of Abilities in Drawing and Description
48 Adult Students

	A	B	C		A	B	C
Name	Rank in Drawing	Rank in Description	*D* or Difference in Rank	Name	Rank in Description	Rank in Drawing	*D* or Difference in Rank
				(Continued from below)			
Boden	1	16	15	Wagner	25	10	15
Mitch	2	33	31	Rhodes	26	22	4
Hope	3	18	15	Geilen	27	7	20
Donson	4	43	39	Whitem	28	37	9
Harmon	5	35	30	Cato	29	31	2
Hosmer	6	4	2	Thomas	30	45	15
Cragun	7	1	6	Hutch	31	42	11
M'C'mb	8	26	18	Russ	32	2	30
Hubb	9	11	2	Allen	33	38	5
Dohert	10	13	3	Cowan	34	47	13
Weber	11	32	21	M'Cann	35	12	23
Colpit	12	29	17	George	36	8	28
Kerst	13	21	8	Fogel	37	46	9
Smith	14	36	22	Moss	38	20	18
Shield	15	27	12	Heig	39	15	24
Carr	16	6	10	Duffy	40	17	23
Burg	17	23	6	Cano	41	25	16
Hughes	18	3	15	Buch	42	19	23
Brown	19	14	5	Snod	43	24	19
White	20	5	15	Butler	44	28	16
Porter	21	48	27	Yarbo	45	41	4
Ganard	22	9	13	Ferry	46	30	16
Cowart	23	34	11	Zeller	47	44	3
Jenn	24	39	15	Kenn	48	40	8
	(Continued above)						
							48)712

Average Rank Difference = 14.9
Average Chance Difference = 16.

r = .200 P.E.$_r$ = .09 R = .079

Table VIII

Comparison of Abilities in Drawing and Description
50 College Students

	A	B	C		A	B	C
Name	Rank in Description	Rank in Drawing	*D* or Difference in Rank	Name	Rank in Description	Rank in Drawing	*D* or Difference in Rank
				(Continued from below)			
Halm	1	43	42	Hone	26	32	6
Clark	2	45	43	McIll	27	27	0
Bloys	3	36	33	Park	28	48	20
John	4	20	16	Huston	29	8	21
Lewis	5	12	7	Moss	30	31	1
Miller	6	47	41	Tuny	31	14	17
Cume	7	35	28	Webon	32	33	1
Duncam	8	39	31	Scott	33	22	11
Mull	9	19	10	Rankin	34	28	6
Webb	10	49	39	Quinn	35	13	22
Alex	11	34	23	Bland	36	5	31
Crook	12	1	11	Erhart	37	23	14
Ever	13	3	10	Fite	38	37	1
Weir	14	6	8	Hug	39	4	35
Powe	15	16	1	Mill	40	50	10
Angus	16	11	5	Walters	41	42	1
Cole	17	40	23	James	42	30	12
Mann	18	2	16	Coon	43	44	1
Oxly	19	10	9	River	44	23	21
Evert	20	46	26	Kalt	45	41	4
Fogal	21	17	4	Habt	46	18	28
Wills	22	24	2	Ellin	47	7	40
Woods	23	9	14	Peter	48	26	22
Austin	24	36	12	Doby	49	25	24
Cordy	25	15	10	Betts	50	29	21
(Continued above)							

50)834

Av. D. = 16.68
Chance D. = 16.66

$r = -.041$ P.E.$_r = .1$ $R = -.001$

TABLE IX

Comparison of Abilities in Drawing and Description
Group A, 30 College Students;
Group B, 31 College Students.

Group A			*Group B*		
Rank in Drawing	Rank in Description	*D*	Rank in Drawing	Rank in Description	*D*
1	5	4	1	25	24
2	13	11	2	20	18
3	7	4	3	15	12
4	26	22	4	4	0
5	16	11	5	7	2
6	29	23	6	26	20
7	17	10	7	1	6
8	3	5	8	31	23
9	2	7	9	3	6
10	6	4	10	28	18
11	12	1	11	13	2
12	14	2	12	9	3
13	28	15	13	5	8
14	23	7	14	16	2
15	20	5	15	14	1
16	24	8	16	29	13
17	21	4	17	2	15
18	27	9	18	11	7
19	9	10	19	27	8
20	25	5	20	8	12
21	19	2	21	10	11
22	1	21	22	21	1
23	15	8	23	6	17
24	18	6	24	30	6
25	4	21	25	17	8
26	22	4	26	23	3
27	9	18	27	12	15
28	8	20	28	24	4
29	10	19	29	22	7
30	30	0	30	19	11
			31	18	13
		30)286			31)296
		Av. D. = 9.53			*Av. D.* = 9.55
		Chance D. = 10.00			*Chance D.* = 10.33
r = .074		R = .047	r = .151		R = .076
		P.E.$_r$ = .12			P.E.$_r$ = .12

The names of the subjects are omitted in Table IX. The figures indicate the rank of the individuals in the series stated at the head of the column.

The amount of correlation discovered between drawing and description in the five groups of subjects who were tested in Experiment I is shown in Summary form in Table X. The *Av. D.*, the *Chance D.*, the degree of correlation by the Pearson method (r), its *Probable Error* (P. E.$_r$), and the degree of correlation by the Spearman method (R), is given for each group, together with the averages of the five groups.

TABLE X

Correlation between Drawing and Description

	Number Subjects	Average Rank *D*	Chance Rank *D*	r	P.E.$_r$	R
(1)	51	19.90	17.00	—.271	.09	—.172
(2)	48	14.90	16.00	.200	.09	.079
(3)	50	16.68	16.66	—.041	.10	—.001
(4)	30	9.53	10.00	.074	.12	.047
(5)	31	9.55	10.33	.151	.12	.076
All	210	70.56	70.00	.023	.048	.006

Conclusion. The combined results of the tests taken by the 210 subjects show that there is no correlation between ability in representative draw-

ing and ability in description. This is evidenced by the average of the coefficients of correlation determined by the Pearson method (.023), that determined by the Spearman method (.006), and by the equivalence of the *Chance D's* and the *Average D's*. A pupil who is good in description is not necessarily good in drawing. He may be either good, medium, or poor, as chance wills it. Because a pupil can not draw well is not a sign that he cannot describe an object well. There is nothing in common between the two processes which justifies using them for the same purpose in laboratory teaching.

(b) *Correlation between Diagramming-Drawing and Diagramming-Description.* The correlation between abilities in diagramming and drawing and between diagramming and description was estimated for the group of 51 high school students in exactly the same manner as has been described for the drawing-description correlation. The following degrees of correlation were established:

Diagramming-Drawing.....r = —.052
Diagramming-Description.....r = .231

Ability in diagramming (which is a type of analytical drawing) is not, therefore, correlated with ability in representative drawing. On the other hand, the processes of diagramming and description exhibit a positive correlation (.231)

which, although small, is significant of the presence of a common factor between the two. It is evident from the results of Experiment I that the process of representative drawing is similar neither to description nor to diagramming. The processes of diagramming and description, on the contrary, show an intimacy of relationship which is indicative of an inherent similarity between the two. This contrast will receive further emphasis by the results of the experiments to follow.

EXPERIMENT II. DRAWING AND SCHOOL GRADES.

1. *Problem.* To evaluate the correlation between achievement in "school" Drawing and achievement in other school subjects.

2. *Materials.* The materials included the final grades received by 141 normal school students for one year's work in various school subjects including Drawing. All students were required to take Drawing two times per week throughout the year. The total number of grades, exclusive of Drawing, includes 810 individual marks in 28 school subjects taught by 15 different teachers.

3. *Method of Procedure.* It was necessary to adjust the method of correlation to the system of grading in use at the normal school from which the statistics were secured. The different grades assigned under this sytem are 5, 4, 3, 2, 1, and 0. The grades run by theoretically equal steps from

5 for the best grade of work down to 0 for the poorest. It was necessary to shift the marks of four of the fifteen teachers one point in order to make the correlations upon the basis of actually parallel rankings.

Table XI exhibits the method of tabulation and correlation which was followed for all school subjects. The 21 members of the class in Latin are ranked as they stood in the six grades which are possible in Drawing. The rank in Latin is placed directly opposite the rank in Drawing. The difference between the two gives the *Rank Difference* (d). Following this in the last vertical column is the product of the *Rank Difference* squared (d^2), which is required in the computation of the correlation by the (adapted) Pearson formula,

$$r = 1 - \frac{6S(d)}{N(n^2 - 1)}$$

It is necessary to remember that the number of cases differs from the number of ranks. The number of cases (N) varies with the class (in this case, 21); the number of ranks (n) is always 6.

4. *Results.* A summary of the results obtained from the entire 810 pairings is exhibited in Table XII. The several classes are grouped under the titles of Manual Training, Mathematics, Foreign Languages, Household Arts, English, Music, Edu-

TABLE XI

Correlation between Achievement in Drawing and Achievement in Latin as Shown by School Grades

Name	Rank in Drawing	Rank in Latin	d	$(d)^2$
Haulot	1	3	2	4
Mullen	2	2	0	0
Thiel	3	1	2	4
Wier	3	2	1	1
Tomkins	3	2	1	1
McComb	3	2	1	1
Austin	3	3	0	0
Behn	3	6	3	9
Corbin	4	1	3	9
Lassator	4	1	3	9
Fogal	4	2	2	4
Pitts	4	2	2	4
White	4	3	1	1
Powell	4	4	0	0
Hodnett	4	4	0	0
Osley	4	4	0	0
Kittle	4	6	2	4
Weather	5	6	1	1
Blount	5	6	1	1
Bloys	6	6	0	0
Johnson	6	6	0	0
$N = 21$			$S(d) = 25$	$53 = S(d^2)$

$$r = 1 - \frac{6\,S\,(d^2)}{N\,(n^2-1)} = 1 - \frac{6 \times 53}{21 \times 35} = .568$$

TABLE XII

Correlation Between Achievement in Drawing and Other School Subjects as Shown by School Grades

Subject	Number Students	Rank Difference 0	1	2	3	4	$S(d)$	R	r
Man. Tr.	18	4	4	5	4	1	30	.16	.28
Mathematics	98	19	45	18	13	3	132	.33	.49
Fgn. Lang.	39	11	15	7	6	0	49	.37	.57
Home Econ.	110	21	58	26	4	1	126	.43	.66
English	144	36	67	31	10	0	159	.47	.68
Music	134	38	58	32	4	2	142	.47	.68
Education	116	31	55	22	8	0	123	.57	.73
History	35	15	10	7	2	0	30	.60	.80
Science	116	41	60	12	3	0	93	.60	.80
All	810	216	372	160	54	7	884	.45	.66

cation, History, and Science. The degrees of correlations between the various school subjects and Drawing are shown in the last two columns by the Spearman and Pearson methods, respectively.

5. *Special Observations.* Any legitimate interpretation of the foregoing array of statistics must take into account the complexity of factors which enter into the assignment of school grades. Special inquiry shows that the grades in Drawing were

computed from a number of separate factors. These include (a) ability in representative drawing, (b) ability in designing, (c) ability in artistic discrimination, (d) ability with color, washes, shading, etc., (e) attendance, (f) discipline, and (g) vocational interest.

Without taking into account the possibility of similar heterogeneity in the grading of other classes, it is evident that the gross correlations found for achievement in school Drawing do not necessarily apply to its individual factors. As a check upon the factor of ability in representative drawing, the drawings of the 51 high school students, which were secured in Part I of Test No. 1, were compared directly to the class standings of the same students. Two correlations were computed by the methods previously described; one with grades in Science, and one with the average of the class standings in Science, English, Latin, and Mathematics. *In neither case was correlation between representative drawing and achievement in school subjects shown.*

6. *Conclusion.* Achievement in Drawing is highly correlated with achievement in other school subjects, averaging nearly 70 per cent. positive. This is, no doubt, due to the fact that the standard of drawing instruction calls for a variety of mental and motor processes which are the same as, or similar to, those found in other

school subjects. Ability in representative drawing is not correlated with achievement in school subjects when it is isolated from the other factors of school Drawing.[1]

Experiment III. Retention and the Devices Used to Secure It.

1. *Problem.* To determine the correlation between retention and representative drawing, description, and analytical drawing.

Two special tests were used for the solution of this problem. Each consisted of an unannounced examination given to test the student's memory of the characteristics of an object which had been drawn, described, or diagrammed previously.

2. *Method of Procedure. Test No. 1. Subjects.* 51 students in a first-year high school class in General Science. (See Experiment I.)

Twenty-four hours after the analytical study of the feather previously described, the pupils were given the following examination:

1. Make a simple diagram of a feather, showing and labeling the parts visible to the naked eye.
2. (a) What difference is there in the two sides of a feather? (b) What difference is there between the upper and lower surfaces?

[1] See also Albien's experiment, p. 36.

3. Explain in detail how the various parts of a feather are held together.

4. Distinguish two kinds of barbules as to their shape and position.

3. *Method of Scoring.* The examination papers were carefully scored on a basis of points similar to that described for the scoring of descriptions and diagrammatic drawings. (See Experiment I.) The pupils were then ranked according to the degree of merit of their answers to the questions of the test. As the questions involve the recall of the essential characteristics of the feather, the results exhibit the comparative amount of retention possessed by each student. By comparing the position of an individual pupil in retention with his position in representative drawing, description, or analytical drawing, it is possible to determine the degree of correlation present between retention and each of the devices used to secure it.

4. *Results of Test No. 1.* Table XIII shows in detail the correlation which exists between these several devices and retention. Considered as a measure of the group as a whole, the individual tabulations in Table XIII may be reduced to the following general correlations:

Representative Drawing and Retention.. $r = -.022$
Description and Retention..... $r = .234$
Analytical Drawing and Retention..... $r = .433$

TABLE XIII

Correlation between Retention and Representative Drawing, Description, and Analytical Drawing

Rank in Memory	Rank in Drawing	Rank in Description	Rank in Diagram	Rank in Memory	Rank in Drawing	Rank in Description	Rank in Diagram
1	38	2	1	(Continued from below)			
2	41	14	5	26	24	7	2
3	37	1	14	27	6	32	47
4	22	30	41	28	16	34	18
5	7	46	4	29	20	31	8
6	17	20	10	30	4	50	22
7	48	22	43	31	44	18	40
8	27	19	6	32	19	4	17
9	42	6	27	33	13	48	45
10	39	9	31	34	33	16	33
11	31	44	19	35	11	8	44
12	36	10	9	36	23	47	36
13	18	41	26	37	1	43	38
14	21	29	12	38	43	33	29
15	9	38	23	39	8	36	11
16	35	13	35	40	29	42	21
17	51	37	24	41	30	3	46
18	25	35	39	42	2	26	42
19	10	24	34	43	47	28	28
20	26	5	25	44	32	21	7
21	12	17	30	45	15	27	20
22	28	49	51	46	46	39	47
23	34	25	13	47	49	11	16
24	3	12	15	48	50	40	50
25	45	45	3	49	5	45	30
(Continued above)				50	40	23	48
				51	14	51	49

5. *Conclusion.* There is no correlation between skill in representative drawing and subsequent retention of the essential characteristics of the object drawn. There is noticeable correlation (.243) between ability in description and retention. There is marked correlation (.433) between ability in analytical drawing and subsequent retention. These facts are of the utmost importance to laboratory teaching and will receive further comment in the concluding chapter.

6. *Method of Procedure. Test No. 2. Subjects.* 61 college students.

It is frequently held that, whatever else may be lacking, the process of drawing compels the observation of form and color. In view of this claim, a special test was devised to compare the amounts of retention of this type secured by the devices of drawing and description.

The subjects of the test were divided into two groups, A and B, of 30 and 31 members, respectively. Each member of Group A was given a triangular metallic object (see Figure 3), designated as the "triangle." Each member of Group B was given a small metallic sash-lift (see Figure 4). They were given similar drawing materials and instructed as follows:

Part I.

Write your name at the top of the page of drawing paper. Place the object in position as

directed and draw it so that it may be identified by your drawing. (Time allowed, 8 minutes.)

The members of Group A exchanged objects with Group B, and all were directed:

Part II.

Write your name at the top of he page. Place the object in position as directed and describe it so that it may be identified by your description. (Time allowed, 8 minutes.)

The danger of mental superiority on the part of one group over the other was obviated by the exchange of objects between the two parts of the experiment, which permitted all of the subjects both to draw and to describe.

Five days later the same subjects (one absent) were given an unannounced examination to test their retention of the elements of form and color which had characterized the two objects.

Part III.

Directions after passing paper: "I am about to ask you a series of questions concerning the objects which you drew and described five days ago. I am extremely anxious that no one shall in any way be aided by any other student, so I shall insist that you keep your eyes away from the work of other students, and that you neither make comments nor ask questions which may be in the least suggestive to other members of the class."

The questions below were then read and answered one at a time, each student writing his answer. When necessary, the exact meanings of the directions were illustrated by diagrams on the blackboard.

Set I. Sash-lift.

Write your name at the top of the page. State whether you drew or described the sash-lift.

1. Draw a line indicating the greatest width of the flat part of the sash-lift.

2. Draw a line indicating the least width of the sash-lift.

3. What is the ratio of the thickness of the material at the edge of the object, to that of the edge of a half-dollar; approximately, (a) two times as thick, (b) one and a half times as thick, (c) as thick, (d) two-thirds as thick, (e) one-half as thick, or (f) one-fourth as thick. (Each student was given a half-dollar for comparison at this point.)

4. Were the holes in the flat part, (a) nearer to the edges of the sides, (b) the base, or (c) were they the same distance from each?

5. (a) Draw a circle indicating the size of the upper opening of one of the holes; (b) also a circle indicating the size of the lower opening. (The *outside* of the pencil mark is to be taken in these questions.) (c) Draw a line indicating the distance on the upper surface of the sash-lift between the two holes (measuring from inner edges).

6. Was the upper surface (a) polished approximately smooth, or (b) were there numerous slight indentations or abrasions upon it?

7. Was the exact contour of the upper part of the finger piece from the front (a) regularly rounding, or (b) somewhat flattened?

8. State the color of the following areas of the sash-lift. (A diagram was drawn on the board and lettered, which divided the front and back surfaces of the sash-lift in six parts each. Two of these parts in the original were copper-colored, the remainder nearly black.)

Set II. Triangle.

Write your name at the top of the page. State whether you drew or described the triangular object.

1. Draw a line indicating the exact length of one side of the object from tip to tip.

2. Draw a line indicating the exact length of one of the outer sides of one of the inner triangles.

3. What is the ratio of the thickness of the material at the edge of the object, to that of the edge of a ten-cent piece; approximately, (a) two times as thick, (b) one and a half times as thick, (c) as thick, (d) two-thirds as thick, (e) one-half as thick, (f) one-fourth as thick. (Each student was given a ten-cent piece for comparison.)

4. Were the three sides of the inner triangles (a) equal in length; (b) equally curving; (c) parallel, or askew, with the near sides of the outer triangle?

5. (a) Draw a circle, the outer edge of which indicates the exact size of the hole in the center of the triangle. (b) Draw a line indicating the exact distance from the edge of the hole in the center to the nearest point of one of the sides of the triangle.

6. Was the surface of the object (a) polished approximately smooth, or (b) were there slight indentations or abrasions upon it?

7. Were the outer points of the triangle (a) regularly rounded, or (b) somewhat flattened?

8. (a) Were the lines which delineated the various triangular figures on the *concave* side of the object grooves or ridges? (b) On the *convex* side?

7. *Results of Test No. 2.* The results obtained from the foregoing test were concrete in character and readily submitted to objective measurement, which was carried out with accuracy and detail. The average error or percentage correct of each detail of the test was computed for both drawers and describers. The tabulated results are exhibited in Tables XIV, XV, and XVI.

Drawing proves to be no better than description as a device for securing retention of surface dimensions. It was 6% less efficient than description with fine dimensions, and markedly inferior with the dimension of thickness. In the total recall of all dimensions, based upon 330 judgments, description surpassed drawing by over 6%.

TABLE XIV

Memory for Surface Dimensions

Gross Dimensions	Average Error Made by Drawers	Describers
Length of sash-lift.....	14.7%	17.0%
Width of sash-lift.....	18.7%	15.7%
Length side triangle.....	11.6%	9.5%
Side inner triangle.....	26.7%	27.7%
Average total.....	17.9%	17.7%
Fine Dimensions		
Between holes.....	71.0%	47.0%
Triangle hole.....	38.0%	34.1%
Center to edge.....	46.0%	60.0%
Upper hole.....	23.0%	19.7%
Under hole.....	32.4%	22.0%
Average total.....	42.1%	36.6%
Thickness		
Triangle.....	41.9%	41.4%
Sash-lift.....	97.0%	56.0%
Final average error....	38.3%	31.8%

Neither drawing nor description exhibited marked superiority in the retention of the elements of general design.

The process of description is markedly superior to that of drawing as a device for securing retention of color. The ratio of correct judgment is nearly 2 to 1 in favor of the pupils who made descriptions of the objects.

TABLE XV

Memory for General Design

	Drawers Rights	Describers Rights
Contour of:		
Sash-lift	22%	35%
Triangle	73%	70%
Position of:		
Sash-lift holes	20%	50%
Triangle holes	73%	65%
Surface Markings:		
Grooves, etc.	93%	93%
Abrasions, Triangle	93%	93%
Abrasions, Sash-lift	90%	89%
Final average rights	67%	71%

TABLE XVI

Memory for Color

	Drawers Rights	Describers Rights
Number seen	77.0%	100.0%
Position	3.0%	55.0%
Areas	38.8%	71.3%
Average rights	39.6%	75.4%

8. *Conclusion.* The results of Experiment III give positive evidence that representative drawing is not a successful device for securing the analytical observation necessary to successful retention. Even in its own domain of form and dimension it is no better than, and in all probability not equal to, the process of description.

Experiment IV. Analysis of Observation During Representative Drawing and Description.

1. *Problem.* To determine the direction of attention during drawing and description.

2. *Method of Procedure. Subjects.* 48 university graduate students. (See Test No. 2, p. 91). Immediately after spending seven minutes each in describing and drawing a microscope clip, the subjects of this experiment were given the following directions:

> *Directions.* Introspect carefully, and proceed as follows:
>
> State in writing as definitely as possible any differences which distinguished your consideration of the object (a) while drawing it from that (b) while describing it, such as:
>
> 1. Aspects or characteristics of the object which held your attention during (a) and (b) above.
> 2. Kind of mental analysis of the object or mental procedure during (a) and (b).
> 3. Difficulties in the technique of expression during (a) and (b).
> 4. Any other specific difference which you may have experienced.

The majority of these subjects had had considerable training in psychology and were able to make a satisfactory psychological analysis of their previous attempts at observation. The following summary presents the results obtained from

the foregoing introspections. It has been verified frequently since the original experiment.

3. *Results.*

ANALYSIS OF DESCRIPTION AND DRAWING

Scope of Attention

Description	*Drawing*
1. Many categories of characteristics, such as: (a) spatial, (b) visual, (c) nomenclature, (d) classification, (e) material, (f) use, (g) construction, (h) kinaesthetic, (i) aesthetic, etc.	1. Characteristics limited to three categories: (a) spatial; —proportions, (b) visual; —appearance, (c) aesthetic; —beauty.
2. Absolute circles, angles, dimensions, etc.	2. Circles, etc., modified by distance and perspective.
3. All parts significant.	3. Surface view significant.
4. Object dynamic.	4. Object static.

TYPE OF MENTAL ANALYSIS

Description	*Drawing*
1. Dealing with concepts.	1. Dealing with percepts.
2. Rational analysis and synthesis.	2. Imitative reproduction.
3. Constant comparison with previous knowledge; "association."	3. Constant comparison with appearance of resulting drawing; "isolation."
4. A sequence of ideas and definitions logically developed into a whole.	4. Any part may be drawn into the whole at any time.
5. Many categories of thought. Desire to dissect.	5. Two groups present in class: (a) limited categories—geometrical, (b) trial by error methods.
6. Mental activity more intense.	6. Mental activity relieved by motor.
7. Various types of imagery used.	7. Visual imagery used.

DIFFICULTIES

Description	*Drawing*
1. Lack of proper words to express meanings realized.	1. Lack of control of hand in attempting lines.
2. Not knowing how to be definite.	2. Not knowing how to produce three-dimension effects.
3. Failure to think of attributes.	3. Failure to select elements of form.
4. Incompleteness.	4. Incorrectness.
5. Difficulties with organization of elements into a logical whole.	5. Difficulties of organizing details into a unified whole.

EXPERIMENT V. THE EFFECT OF ANALYTICAL OBSERVATION UPON DRAWING.

1. *Problem.* To determine the effect of analytical observation upon ability in representative drawing.

2. *Method of Procedure. Subjects.* 16 graduate students. A stuffed bird, the black-crowned night heron, was placed before a group of students for study. The students had never seen this species of bird before and none of them was acquainted with the methods of bird study. They were first acquainted with enough anatomical terms to enable them to follow the directions. The class was then divided equally into two groups. A and B. The members of both groups were given the following directions:

Directions. Answer the following questions on the paper supplied:

1. What is the shape of the bird's bill?
2. What is the condition of the crown? The forehead?
3. What is the position of the wings at rest with reference to the body and tail?
4. The knee is concealed by the plumage. The first visible joint is the heel. The bone connecting the heel and the foot is the metatarsus. Which way does the heel bend?

Each group was then given a special direction for observation which was not given to the other group. The directions follow:

Group A. Note carefully the comparative lengths of the bill and meta-tarsus.

Group B. Note carefully the number and comparative lengths of the front and hind toes.

Finally, both groups were given the following direction:

Direction. Make a drawing of the night heron. Draw the bird in any convenient position.

3. *Results.* The parts to which attention had previously been called were more accurately drawn than the parts which had not received mention. Group A, which had been directed to observe the comparative lengths of the bill and metatarsus, drew this feature with much greater accuracy than Group B, which had not received this instruction. Table XVII gives the comparative measurements of the drawings of the two groups for this feature. Other features exhibited similar results.

TABLE XVII

Comparative Length of a Bird's Bill and Meta-tarsus Drawn with and without Previous Analytical Study. The Bill and Meta-tarsus are Actually of Equal Length.

Group A (*After analysis*)			*Group B* (*Without analysis*)		
Student	Length of bill	Meta-tarsus	Student	Length of bill	Meta-tarsus
A.K.	25 mm.	24 mm.	A.P.	14 mm.	20 mm.
L.M.	25 "	28 "	L.W.	35 "	40 "
F.P.	20 "	20 "	C.R.	35 "	58 "
F.S.	9 "	9 "	H.M.	18 "	45 "
R.C.	25 "	20 "	J.P.	4 "	8 "
E.W.	30 "	32 "	O.P.	25 "	35 "
W.M.	24 "	25 "	E.B.	28 "	35 "
J.S.	19 "	17 "	S.J.	15 "	25 "

4. *Conclusion.* Analytical observation improves the ability to make a representative drawing. Greater accuracy of dimension is exhibited after such study. Group A, above, after having their attention directed to the comparative length of the bird's bill and meta-tarsus, drew it with approximate accuracy. Group B, without such directed attention, made errors anywhere from 15 to 250 per cent.

Chapter VII

FINAL CONCLUSIONS

I. The Psychological Analysis of Drawing.

The psychological analysis of drawing shows that the process of graphical expression is subject to the influence of three interrelated factors, (1) a preconceived purpose, (2) ability to see, and (3) ability to represent.

1. *The Preconceived Purpose.* The preconceived purpose of drawing varies with the individual and the occasion. It may be (a) to fix an object in consciousness, (b) to catalogue items of information, (c) to make a visual representation, (d) to interpret an artistic sentiment, or (e) to illustrate a scientific concept. One decides to sketch a route to the next village, another to record the parts in an automobile wheel, a third to draw a picture of his house, a fourth to interpret the tragedy of war, and a fifth to demonstrate the action of a force-pump. Then follow, each subject to the original intent of the effort, the direction of attention, the play of memory, the marshalling of ideas, the choice of interpretation, and the guidance of the hand. Whatever it may be, the purpose of the moment dominates the entire process of graphical expression.

2. *The Ability to See.* (See pp. 97–99.) The ability to discriminate the particular characteristics of an object which should be shown in a drawing depends upon both native talent and training.[1] A certain inherent perspicacity for, and a predisposed tendency toward, analytical observation are fundamental and peculiar to each type of drawing. One individual may be given to the type of analysis which is demanded by artistic drawing, another to the analysis required by scientific drawing, and a third to that necessitated by representative drawing. Each proclivity favors one type of drawing and interferes more or less with the others.

On the other hand, the ability to see with discrimination may be greatly improved by training. (See p. 103.) One learns by experience to discover more readily the lines which exhibit artistic beauty, is taught to discriminate characteristics which are scientifically important, or comes in the course of training to recognize elements of form which carry representative value. Successful training in any one or all of these is not impossible to any normal child.

3. *Ability to Represent.* Given the same preconceived purpose and ability to see discriminatingly, achievement in drawing depends upon a number of closely interrelated factors.

[1] See footnote, p. 100.

(a) *Visual Imagery.* The clearness of visual imagery, particularly in memory drawing, is of great importance to accurate representation and is subject to great individual variation. With different individuals the drawing image may be (1) clear and distinct, (2) vague and incomplete, (3) distinct, but inaccurate, or (4) changeable and evanescent when the act of drawing begins. (See pp. 93, 94, and 99.)

(b) *Reflection.* Knowledge of the physical characteristics of an object may serve to strengthen the visual image or even to substitute for it, as when one recalls that an object is just twice as long as it is broad. (See pp. 93–95.)

(c) *Memory Devices.* The memory may be fortified by the acquisition of drawing schemata of common objects. The possession of a typical dog schema, for instance, is of great service when one attempts to make a drawing of the village bulldog "Buster." (See p. 100.)

(d) *Hand Control.* The control of the hand movements when making regular lines which coordinate with the image or percept of the object fundamental to accurate drawing. (See pp. 99–100.)

(e) *Principles of Drawing.* An acquired knowledge of drawing is necessary for the purposes of visual representation. (See p. 100.)

(f) *Synthetic Capacity.* All drawing depends upon a final synthesis of the elements which have been isolated during the analysis which precedes the use of the pencil. (See p. 76.) One of the earliest of the child's difficulties with drawing is his incapacity to assemble parts into a synthesized whole. He is unable, for instance, to arrange the human features which he knows as separate units into a uniform face. Later on, synthetic incapacity remains to mar the symmetry of visual representation. Many drawers never see the "whole" object well enough to fit in the parts symmetrically. Finally, it is synthetic incapacity that sets the limits to the artistic interpretation of beauty and the scientific discovery of law.

II. Adaptation of Laboratory Teaching.

The psychological analysis of the drawing act shows that there is great variation among different individuals in ability to draw and in the manner in which graphic expression is utilized. Laboratory procedure must be adapted to these variations before the highest type of instruction is attainable.

One of the earliest necessities, therefore, in science teaching is a study of the graphic propensities of individual students. This may be done by subjecting them to tests similar to those described in Chapters V and VI. The teacher should

know the degree of ability and the cause for the superiority or the deficiency of every student in description and in representative, memory, and analytical drawing. Means should then be taken to improve defective ability whenever possible by special training and, whenever impossible, to adjust laboratory practice to the capability of the student.

Improvement in the art of scientific expression may be secured through the co-operation of teachers of English and Drawing. The descriptions resulting from the foregoing experimental tests indicate that many of the subjects have had deficient training in accuracy of verbal expression. (See Test No. 2, p. 113.) General terms and figures of speech often deceive both writer and reader as to the actual lack of any genuinely specific statements. Each reader supplies a different set of imagery, which proves frequently upon psychological analysis to be widely removed from the reality of the original material. The pupil's description of a feather usually reads well if no check is made upon what is specifically said, because the reader unconsciously fills in the gaps with his own previous knowledge. It is different with a strange object like a microscope-clip. For most persons the expression "microscope-clip" fails to arouse any image or tendency to react toward it, and the student feels at once his

need for specific terms of description. One college graduate was unable to write a single word of description about the microscope-clip, and a number of others were practically helpless. Without question training in scientific expression is a legitimate, and should become a regular, part of the work in English.

Achievement in scientific expression is similarly closely related to Drawing instruction. Moreover, the development of skill in analytical "seeing" is essential to the interests of artistic expression itself. (See pp. 96 ff.) Drawing from memory, appreciation of the scientific principles of drawing, ability to modify representative drawings so as to express some aesthetic ideal or to interpret or emphasize some salient aspect of an object or scene—one and all are dependent upon analytical observation. It is, therefore, not only important to the interests of science, but desirable from the artistic point of view, that pupils learn early to analyze with discrimination for each type of graphical expression, whether it be visual representation, artistic interpretation, or scientific illustration.

III. Analytical Observation.[1]

Laboratory procedure makes use of three devices to stimulate analytical observation, (1) repre-

[1] See p. 5 for definition of analytical observation.

sentative drawing, (2) description, and (3) analytical drawing.

1. *Representative Drawing.*[1] Representative drawing does not insure a consideration of the scientific aspects, or an analytical study of an object. (See Experiment IV, p. 150.) The preconceived purpose of reproducing a visual copy narrows the scope of observation, and the attention, at best, is directed to items of form and color. There is nothing to call up associations which have to do with scientific ends. The attention is, in fact, kept away from the associations that have to do with science as such. Even in the province of form, sustained attention is not necessary. The pupil's drawing is always subject to direct comparison with the object at hand, so that extended study and reflection over its proportions are not necessary. It is a waste of time for the interests of scientific thinking to require pupils to spend extended periods of time at representative drawing. In fact, it is worse than a waste of time, for it encourages bad habits of analytical study which are opposed to interests of scientific thinking and constructive research. It is no wonder that so few of our picture-laden notebooks give evidence of scientific grasp or initiative. The excessive use of representative drawing is a serious pedagogical formalism which

[1] See p. 6.

produces copyists instead of scientists and which creates distaste instead of enthusiasm for science.

2. *Description.* The preconceived purpose of description gives a much broader direction to attention. (See Experiment IV, p. 150.) The attempt to describe an object directs attention to a large number of its characteristics and initiates an effort toward an analysis in terms of the subject's own knowledge and previous experience. The student who attempts to describe a feather thinks of its color, its shape, its use; all he has ever known or thought about it is subject to the play of his reflection. The attitude of mind brought about is ideal, but for purposes of scientific analysis it lacks specific direction. The pupil is frequently unable to determine what characteristics of the object are of scientific importance. He not unlikely devotes the major portion of his time to describing the intricate color pattern of the feather, and may overlook entirely the structural elements which adapt the feather to the service of protection or of flight. It is necessary, therefore, to supplement and direct the pupil's attempt at description.

3. *Analytical Drawing.*[1] The preconceived purpose of analytical drawing supplies the direction of attention which is lacking in spontaneous description. The attention is directed to the

[1] See pp. 6–8 for definition of analytical drawing.

particular characteristics of the object which are of immediate scientific concern. The successful type, schematic, or diagrammatic drawing cannot be made without analytical study. The student who attempts to make a diagrammatic drawing showing how the parts of a wing feather are held together has before him a definite problem in analysis which necessitates sustained mental effort to the end of the process of representation. (See Experiment I, p. 107.)

IV. Laboratory Records.

1. *Representative Drawings.* The results of the various special tests show that representative drawings do not afford a measure of the pupil's progress or an adequate record of the work which he has accomplished.

2. *Description.* Description is a desirable record of the work of the pupil. It covers a wide range of observation and lacks only in the matter of the extra time required for the preparation of accurate and comprehensive statements, and for the teacher to make critical inspection.

3. *Analytical Drawings.* Analytical drawings are ideal records of work accomplished and should be used wherever adaptable to the laboratory exercise. They require but a minimum of time for execution, can be made without exceptional skill of hand, and may be readily inspected.

V. Retention.

1. *Representative Drawing.* Representative drawing does not aid the memory. (See results of Experiment III.) As far as scientific concepts are concerned, it interferes with it. Many individuals who can make excellent representative drawings are unable to remember what the object looks like. They fail in the attempt to draw from memory because of faulty and inaccurate observation. Memory tests show that there is no correlation between retention and ability in representative drawing. (See p. 142.)

2. *Description.* Description aids retention by establishing numerous secondary associations during the period of observation and writing. (See pp. 142 and 152–153.) Subsequent recall is greatly facilitated by the number and strength of these associations.

3. *Analytical Drawing.* Analytical drawing aids retention in the same manner as does description. Ability in analytical drawing is positively correlated with retention. (See p. 142.) The visual memory of the analytical schema serves as an additional support for the recall of associated ideas.

4. *Memory Drawings.* The attempt to draw from memory tests the retention of space and form relationships. (See pp. 98 ff.) By means of subsequent comparison of the defective memory

drawing with the real object, the attention is directed to the things which had escaped recall while drawing. For instance, one attempts to draw his watch from memory and puts the second dial near the center. He then compares his drawing with the watch. What happens? He immediately scrutinizes the characteristic which his earlier observation has failed to fix correctly in memory. Thus the attempt to draw from memory supplies the direction of attention to the visual characteristics of an object which is lacking in representative drawing.

VI. Recommendations.

1. It is recommended that the directions of laboratory teaching shall be specifically adapted to the scientific purport of the hour. The directions given for the conduct of Parts III and IV of Test No. 1, Experiment I, in the preceding chapter, are suggested as typical of the proper laboratory procedure. (See pp. 111 ff.)

2. It is recommended that science teachers shall make an early study of their pupils to discover individual variations in skill at graphic expression, and that laboratory instruction shall be adapted to the needs and capabilities of the individual members of the classes.

3. It is recommended that special attention shall be given to training pupils in the art of

scientific expression by teachers of English and Drawing.

4. It is recommended that the device of representative drawing shall be supplanted in laboratory teaching by the use of description, memory drawing, and analytical drawing.

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INDEX