HOW PEOPLE
LOOK AT PICTURES

A STUDY OF THE
PSYCHOLOGY OF PERCEPTION IN ART

By

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ACKNOWLEDGMENT

The investigation reported in this monograph was made possible by an appropriation from the Carnegie Foundation for the Advancement of Teaching. This grant was supplemented by a small sum given by the Social Science Research Committee of the University of Chicago.

The eye-movement apparatus used in this study was built in the shop of the Department of Education by Mr. Ralph B. Larsen, the mechanic for the Department’s laboratories in Educational Psychology. The writer is especially indebted for technical assistance in carrying on the investigation to Miss Lenore John, a member of the staff of the Laboratory Schools of the University of Chicago, and to Mrs. Dorothy Holmes, who acted as laboratory assistant during the entire period of the investigation. Acknowledgment is also made of the helpful advice and co-operation in securing subjects given by Dean Charles F. Kelley and Associate Dean Norman Rice of the Art School of the Art Institute of Chicago.

G. T. B.

February, 1935
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INTRODUCTION

MISS W. was asked to look at a set of large colored pictures as she would if she were selecting one of the pictures for her own. As she looked at the pictures a photographic record was obtained of her eye movements from which an exact reproduction of her pattern of visual perception was made. In looking at the picture “Stowing the Sail—Bahamas,” reproduced here in black and white instead of color as Plate I on page 2, Miss W. made the sequence of visual fixations which is shown by the dots and lines superimposed on the dim print of the picture which appears as Plate II on page 3 of this report. The small black dots on the picture indicate the centers of successive fixations of the eyes, while the numbers beside the dots show the serial order of the fixations. The lines are drawn to connect the dots in series.

In looking at the picture Miss W. first looked at the position of the dot marked “1,” located just below the mast of the boat. Her second, third, and fourth fixations led to the boatman’s head on the right. Fixations 5 to 8, inclusive, made a swing to the lower part of the small boat and back again to the boatman’s head. From this position there follows a series of fixations which makes a survey of the center and forward parts of the boat. The small red flag hanging from the rigging does not receive direct attention until the fourteenth fixation. Fixations 20 to 33, inclusive, permit a reobservation of the boatman and the small rowboat. The latter portion of the time spent on the picture is given mostly to the green water in the lower left corner. At the end of the forty-fifth fixation Miss W. signaled for the next picture to be shown.

Certain general facts are apparent from the pattern of perception as shown in Plate II. This particular subject gave no direct attention to the upper third of the picture. Likewise, the lower right corner of the picture received no direct observation. Whatever impressions Miss W. had from these parts of the picture came through peripheral vision. Also, it is apparent that the boatman and the rowboat in which he is standing received a very large part of the subject’s attention. Another general center
of interest seems to be the fore part of the large boat where the dots cluster in three subcenters of attention. The tall mast and the rope leading upward to its top receive no direct observation whatever. Regardless of whatever may have been the artist's intentions when he painted the picture, the facts remain that at this particular time the visual response of Miss W. to the picture was as indicated in the pattern of perception shown.

The nature of Miss W.'s response can be made still more interesting by adding to the diagram showing the position of her successive fixations some information concerning the duration of each of the fixations of her eyes. By a method to be described later it is possible to determine with precision the duration of each successive fixation pause as Miss W. looked at the picture. The unit used in measuring the duration of the fixations is one-thirtieth of a second. In thirtieths of a second the durations of the first five fixations were, respectively, 2, 10, 11, 14, and 9. Certain of the fixations were considerably longer than others. For example, Fixation 38 was 25 thirtieths of a second in duration, while Fixations 41 and 44 were respectively 24 and 16 thirtieths of a second. The cause of such variations in duration will be considered in a later chapter.

A second example of a pattern of perception is shown as the record of Miss D. in looking at a colored painting of a plate. The picture used is reproduced without color in Plate III, while the dots and lines showing the pattern of perception are shown in Plate IV. In looking at this picture Miss D. made her first three fixations near the center of the plate. Fixation 4 is in the upper left direction and is followed by a series of seven fixations, Numbers 5 to 11, inclusive, which cover approximately a third of the border of the plate. At Fixation 12 the eye swings back to the center of the picture and in the following fixations, 13 to 27, inclusive, the eye makes a general survey of the center portion of the plate in two somewhat circular movements. Fixations 29 to 32 fall in the border at the base of the plate, whereas the last two fixations return to the center of the picture. The durations of Miss D.'s fixations vary from 3 to 15 thirtieths of a second.

PROBLEM

The two cases which have been described in the foregoing pages give a very limited answer to the question, "What does a person do when he looks at a picture?" This question is obviously a very general one which may be restated as a series of specific questions relating to the nature of
the processes of perception and attention while studying any work of art. Certain of these questions relate to the characteristics of the picture being observed. For example, what is the effect of color or lack of color? What are the main centers of interest in looking at a picture? Does the pattern of perception reflect the way the various parts of the picture are balanced? Other questions might be asked relating to the characteristics of the persons looking at a picture. For example, does previous training or ability in art make a difference in a pattern of perception? Do children and adults look at a picture in the same way? Do Oriental subjects look at a Japanese print in the same manner as Western people? Still other questions might have to do with the conditions under which a picture is observed. For example, do the directions given to the observer influence the pattern of perception? Do the characteristics of perception vary with the length of time during which a person looks at a picture?

Questions such as the foregoing have been discussed in the literature relating to the psychology of art, but, so far as the writer is able to discover, the attempts to analyze the perceptual process in looking at a picture have been based upon introspective and subjective evidence. In the present study the data are entirely objective. It will be interesting to find the extent to which the objective evidence obtained from photographs of eye movements corroborates the hypotheses which have been built up subjectively relating to the general patterns of perception in looking at pictures.

Many books on the subject of art make reference to eye movements. The statements which are made rest on introspective evidence, but they indicate an acute interest on the part of the artist and the art critic in the nature of the process of visual perception. As samples of the type of references found, the following quotations, selected at random, are given.

"A more or less differentiated pattern, gradually lengthened in its design and intensified in its color, will draw the eye from the lightly developed part toward the more expressive. . . . Since a picture is something different from a section cut out from nature, it must provide a means of allowing the eye to travel through all parts associated within the frame."

"Then as the beholder stands back from the canvas to take in the ensemble, his eye is pleased by the color-harmony, it rests lovingly upon the balance of the composition, and follows with satisfaction the rhythmic flow of line."

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"Your eye does not follow the muscle and bone making of the arm. It follows the spirit of life in the arm."1

"And doubtless we have all been conscious at times of our eye being swept across a textile or a wall-paper pattern in spite of us. Stop and analyze the situation and it will frequently be found it is due to rhythm by alternation—the alternation of a light with a dark unit, of a large with a small unit, of one hue with another, or one shape with another, and so on. Some rhythms by alternation are so compelling as to be irritating. They snatch our eye and away they go! A motor that runs away with us is much worse than one that sticks on dead center. But that is not the fault of the principle but rather of the designer. Also the simple repetition of a unique shape is often quite as compelling, carrying our eye across a design like the beat of a drum in a march."2

"In the study of unity through the movement or swing of a picture one soon becomes sensitive to whatever, without right, catches and detains the eye. . . . An appreciation of the movement of a picture—that natural course given to it in the progress of lines or attractive points which carry the eye through it—becomes the initiative in the artist's effort to effect unity."3

"But you will notice, how large a stretch of empty space is left at the top of the lunette, so that the eye is drawn upward and the dignity of the whole decoration thereby elevated."4

"The use of this easy transitional line rather than the contradictory line leads the eye surely, but less harshly to the central figure."5

"The eye follows line. Line directs eye movement. The effects of this movement vary with the type of movement."6

"Lines which carry the eye downward give the feeling of reticence that may amount to dejection. . . . Lines which carry the eye upward give an uplift of spirit as well as of eye movement."7

"Form as well as line directs eye movement. The eye tends to move along the path of least resistance. The vertical rectangle carries the eye upward. The horizontal rectangle carries the eye horizontally. The eye is carried most easily when the form is simple. Details of surface pattern or complicated contour interrupt eye movement."8

7 Ibid., p. 21.
8 Ibid., pp. 24-25.

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The quotations in the foregoing paragraphs are particularly interesting in view of the fact that the writers had no precise objective evidence with which to verify their statements. They are quoted here as samples of the kinds of inferences which appear repeatedly in books on art. The data furnished in the following pages will make it possible to observe the extent to which the various hypotheses regarding eye movements are in harmony with the objective patterns of perception which will be shown.

METHOD AND APPARATUS USED IN PRESENT INVESTIGATION

The method used in this study consists in photographing on a moving film the eye movements of a group of subjects while they look at a series of pictures. The technique is new only in its application to the field of art. There already exists a very considerable literature relating to the movements of the eyes in the process of reading. The resulting analyses of the reading process have been exceedingly valuable in developing improved methods for teaching reading. The nature of the eye movements in reading has been traced from the first grade through the college period and has been studied for a great many different types of reading both in the vernacular and in several foreign languages. Technically the problem of photographing eye movements in reading is much more simple than in the case of looking at pictures, since in reading it is only the horizontal movements of the eyes which are of any great significance. However, in looking at pictures it is necessary to secure simultaneously a record of both the vertical and horizontal eye movements. This involves technical difficulties which were surmounted by the construction of the elaborate apparatus used for the present study. Students in the field of psychology and education are already familiar with the technique of photographing eye movements. However, for readers whose major interest is in the field of art a description of the method and apparatus will be given.

It should be clearly understood at the beginning that the movements of the eyes are significant only in so far as they are symptoms of the perceptual processes which appear while looking at a picture. Ordinarily a person is entirely unconscious of the characteristics of these tiny movements of his eyes and it is entirely impossible for him to describe them accurately even when he gives his close attention to them. Eye movements are unconscious adjustments to the demands of attention during a visual experience. The underlying assumption in this study is that in a visual experi-
ence the center of fixation of the eyes is the center of attention at a given time. If this is true then the record of eye movements in looking at a picture supplies objective evidence of the pattern of perception during that experience. In view of the fact that one's response to a picture is, at least in the first instance, a matter of visual perception, any objective analysis of this process of perception should supply data of considerable significance to the artist.

The present report does not treat in any manner the nature of the process of appreciation while looking at pictures. The evidence in regard to perceptual patterns is entirely objective, but it furnishes no indication, except by inference, as to what the nature of the subject's inner response to the picture may be. The writer prefers that the reader draw his own inferences from the data presented. For example, in looking at a landscape painting such as "The Silence of the Night" the fact that one subject gives a large part of his visual attention to the small section of the picture at the end of the road indicates without any question that the observer was interested in this particular part of the picture, at least to the extent of giving a considerable amount of his time to looking at it. However, the fact that he has a great cluster of eye fixations around this position indicates nothing at all as to whether he approved or disapproved of the artist's treatment of that section, as to whether or not he liked it, or as to what might have been the character of his mental reflections during the time that he was looking at that part of the picture.

The method of securing a record of eye movements consists in photographing a beam of light from a six-volt ribbon-filament lamp reflected first to the cornea of the eye from silvered glass mirrors and then from the cornea to a second set of mirrors, through a camera lens and a set of wedge prisms to a moving kinetoscope film. By means of the prisms back of each lens the beam of light from the eye is split into two beams, one of which is directed to a horizontally moving film and the other to a vertically moving film. In this way the movements of the same eye are recorded on both films. The direction of the pencil of light reflected from the cornea is changed with each movement of the eye. As the subject looks at a picture a photograph is made which records the movements of the eye in a sharply focussed line upon the two films. By means of a fan blade driven by a synchronous motor, the beam of light is interrupted thirty times per second between the lens and the film in such a manner that on the film the line of light appears as a series of dots, each dot representing one-thirtieth of a second of time. By counting the number of dots in each fixation pause it is possible to determine with precision exactly how long a person looked at each position in the picture. Only subjects were used whose vision was sufficiently normal to look at the picture without the use of spectacles. The apparatus used is shown photographed from two positions in Plates V and VI.

The apparatus was built for the particular purpose of this experiment in the workshop of the laboratories in educational psychology of the University of Chicago. Basically the apparatus is a large camera built in such a way that the two films can be moved continuously during the process of photographing. The various lenses and mirrors are simply for the purpose of bringing to a focus on the film the reflection of the tiny spot of light from the cornea of the eye. The light which reflects on the eye originates under the table. It is passed forward through a series of lenses and then upward through two holes in the table, after which it strikes two circular mirrors and is reflected to the subject's eyes. Instead of facing the camera lens, as has been necessary with previous pieces of apparatus of this sort, the subject is placed at right angles to the camera which gives him an open field of vision of whatever size is needed. Small pictures can be placed as close as the normal reading distance of twelve inches, whereas larger pictures can be set back whatever number of feet seems desirable. The provision of this larger field of vision adds a great deal of flexibility to the uses of the apparatus.

The subject sits in a specially constructed chair which can be raised or lowered to the proper height. When he is in position the head rest shown is lowered around the back of the subject's head in order to eliminate head movements. On the whole, the position is comfortable and, after a few seconds of adjustment, the apparatus causes the subject no inconvenience. A record of head movements is obtained for every picture by securing through a second lens on the apparatus a photograph of a beam of light reflected from a chromium bead on a pair of spectacle frames which the subject wears. The use of a head line, particularly for the vertical record, is absolutely necessary to insure precision in plotting the record.

The nature of the film record is shown in Plate VII which reproduces a short section from the beginning of one pair of films. The dots in the lines represent time intervals of one-thirtieth of a second. The straight line on
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Each film is the headline, made by the chromium bead on the spectacle frames. The irregular lines show the successive fixations of the eyes. The upper film shows the horizontal record and the lower film the vertical record. The first fixation is 43100ths of a second in duration; the second, third, and fourth are 19, 16, and 213100ths, respectively. The films are plotted by projecting them through a stereopticon lantern. The vertical and horizontal position of each fixation is recorded on a numerical scale and these positions are then co-ordinated and marked on the picture. Points of reference for fitting the film record to the exact size of the picture were secured from initial fixations on four dots placed adjacent to each margin of the picture. For the complete investigation some 18,000 feet of film were used.

The amount of error involved in plotting the films was studied experimentally with a group of 47 subjects by photographing a series of five dots placed at intervals of one inch in both the horizontal and vertical planes. The deviation of the plotted positions of the fixations from the actual position of the dots was then tabulated. Using the outer two of the five dots as points of reference, the horizontal belongings of the three inner dots fell within two millimeters of the exact position in 72 per cent of the cases and within five millimeters in 91 per cent of the cases; for the vertical movements the corresponding numbers were 75 per cent and 86 per cent. Since an error of even five millimeters in position for pictures of the size used would not affect any of the interpretations made of the data, the technique may be considered well within the necessary range of accuracy. However, in looking at an individual fixation on a picture the reader should bear in mind that the true center of fixation may vary from the indicated one by not more than five millimeters in from 86 to 91 per cent of the cases.

A fixation of the eyes, of course, covers an area rather than simply a point. There is no means of knowing exactly how large the area of clear fixation is. The dots showing the position of fixations should be interpreted as the central points of areas of clear recognition which shade off gradually into areas of peripheral vision.

In looking at a picture, just as in the process of reading, the eye moves in a series of quick jerks and pauses. The eye does not slide over the picture, as many people seem to think it does. The duration of the fixation pauses varies a good deal, a pause of 33100ths of a second being very brief, one of 8 to 103100ths being quite common, and pauses of more than 203100ths of a second occurring only in approximate...
ly 5 per cent of the cases. These movements and pauses of the eyes may be noted by direct observation, but the movements are too rapid to be counted accurately and the pauses too brief to be timed without the use of special apparatus.

SUBJECT AND MATERIALS FOR THE PRESENT INVESTIGATION

Photographic records of eye movements were obtained from two hundred individuals for the present investigation. Of this number 12 were elementary grade children, 44 were high-school pupils, and 144 were adult subjects. Of the adult subjects 47 were secured from the Art School of the Art Institute of Chicago and were persons who had from two to five years of special training in the field of art. Fourteen other subjects had made sufficient study of art to be classified as art students. The great majority of the remaining adult subjects were college or graduate students.

In addition to taking photographic records of eye movements the McAdory Art Test was administered to all of the subjects above the elementary grades. In a later chapter the data from the investigation are analyzed in terms of the amount of training in art school and of artistic ability as measured by the McAdory Art Test.

In the entire investigation 55 different pictures were used. For one group of 9 subjects photographic records were made from 39 different pictures for each subject. Thirty-four subjects looked at 21 or more pictures each. For the remaining subjects fewer pictures were taken. However, the total number of completed records used in this report is 1,877. The only records discarded were those where the amount of head movement was so great as to render doubtful the plotting of the picture or where some ocular defect made the film record unreliable.

A complete list of the pictures used in the investigation is given in Appendix A of this report. The 55 pictures used may be classified roughly into eight different groups as follows: Pictures 1 to 16, paintings, some in color and some in black and white; Pictures 17 to 22, vases and dishes; Pictures 23 to 30, furniture and design; Pictures 31 to 35, photographs of statuary and museum pieces; Pictures 36 to 39, tapestries and designs on cloth; Pictures 40 to 47, architecture and interior design; Pictures 48 to 50, posters; Pictures 51 to 55, outlines, silhouettes, and geometric figures.

The prints and photographs used were of excellent quality. The sizes of the pictures as used and also reduced reproductions are included in Appendix A.

INTRODUCTION

OUTLINE OF REPORT

The data and the results of the investigation will be presented in the following chapters. In chapter ii the principal centers of interest in pictures and the general nature of the perceptual patterns will be treated. Chapter iii will consist in an analysis of the variations in duration of fixation pauses and the relation of these variations to certain aspects of the perceptual process. Chapter iv will deal with certain variations in perception as related to characteristics of the pictures. The principal topics here will be the effects of color, the perception of design, silhouette, and outline, and a comparison of eye movements in looking at finished and unfinished paintings. Chapter v will deal with variations in perception which are related to the characteristics of individuals. Comparisons will be made of persons with and without training in art, of children and adults, and of Western and Oriental subjects. Chapter vi will treat the effect of directions given to the subject prior to looking at the picture. These directions determine the mental attitude or "set" of the individual. The final chapter, vii, summarizes the findings of the investigation and presents some general interpretations of the data.

As far as the writer can ascertain, this is the first experimental study of eye movements in looking at pictures. As is generally the case when a technique is first applied in a new field this study possesses many of the characteristics of a survey experiment rather than one which tests carefully formulated hypotheses. The writer is in a much better position to set up such hypotheses now than at the beginning of the study. Subsequent studies may deal more specifically with some of the problems raised by this one.

This study is an application of certain scientific techniques to problems in art. The writer is not a specialist in art; his contribution is simply the application of techniques, which have been found useful in psychology, to the study of the perceptual process in looking at pictures, a process which is of common interest to both artists and psychologists. In the main, the writer will limit his efforts to the presentation of a body of objective data which relates to many problems of the artist. Rather than risk making interpretations in a field in which he is an amateur, he leaves to the artist the drawing of generalizations which go beyond the common field of the psychology of perception.
CHAPTER II
CENTERS OF INTEREST AND PATTERNS OF PERCEPTION IN LOOKING AT PICTURES

The materials in this chapter will be presented in four sections. The first section will deal with principal centers of interest in pictures as revealed by density plots in which the positions of fixation for a large group of subjects are mapped on a single picture. In the second section a comparison will be made of the initial and the final fixations in looking at a picture. In the third part of the chapter a more detailed analysis of the nature of perception will be made by dividing each of the pictures into sixteen equal rectangles and comparing the amount of visual attention given to each of these parts. In the fourth section individual patterns of perception will be analyzed and a considerable group of sample records will be presented to show the nature of the perceptual process from subject to subject and from picture to picture.

CENTERS OF ATTENTION

A very effective method for pointing out the centers of interest in a picture is to make a density plot or map by combining on a single picture all the dots showing the centers of fixation for a large group of subjects. Such a density plot is exhibited in Plate VIII, for Picture 9, “Stowing the Sail.” This plate shows the distribution of interest for 68 different subjects who in looking at the picture made a total of 3,267 fixations. The parts on the picture which attracted the greatest amount of attention are indicated by the greater density of dots over those areas. It is evident, for example, that the figure of the man constituted one of the chief, if not the chief, centers of interest. Furthermore, it is clear that a very considerable number of fixations converge around the lower part of the mast on the boat. The upper part of the sky received a relatively small amount of attention. Likewise, the water in the lower part of the picture, while it received more notice than the sky, is obviously of less interest to the subjects than the large boat, the man, and the small rowboat in which he is standing. The small red flag which is frequently commented upon as a
pronounced center of attraction in this picture was given a considerable amount of attention, but no more than several other parts of the picture. Judging from the distribution of dots on the density plot, the picture obviously has two main centers of interest, the one in the fore part of the large boat and the other around the man and the portion of the small boat in which he is standing.

A more definite concentration of interest is evident in Plate IX for Picture 12, "The Solemn Pledge." This density plot is based upon 3,763 fixations from 76 different subjects. The outstanding characteristic of the pattern of perception in looking at this picture is the manner in which the fixations are concentrated over the four faces, a degree of concentration which leaves no doubt to which are the principal centers of interest. The faces of the three men receive somewhat more attention than the face of the boy in the lower part of the picture. Although the background of sky and mountain scenery is rich both in color and in detail, the subjects gave little attention to it.

Plate X shows the distribution of attention over Picture 47, a cathedral interior. The principal area of interest here extends vertically throughout the center of the picture. Evidently the circular window, the pipe organ, the choir loft, and the elaborate doors are of approximately equal attractiveness to the subjects. Little difference is apparent in the distribution of fixations on the right and left sides of the picture, the columns and arches on both sides receiving a considerable amount of attention. It is interesting to note that the American flag, which hangs in the upper left of the nave, did not attract any unusual number of fixations. When questioned after viewing the picture, many of the subjects said that they failed to notice that the flag was there. While a density plot, such as is shown in Plate X, is quite illuminating as to the character of perception for this type of picture, the directions of the movements of the eyes can be noted more clearly from other forms of analysis, as will be shown during the latter part of this chapter.

Plate XI, showing the location of fixations for Picture 13, "The Wave," indicates a very considerable spread of interest. There is a conspicuous absence of attention on the sky in the upper right corner and relatively little note taken of the lower left corner, but aside from this the distribution of fixations is quite general. The large wave and the small white mountain are probably the main centers of interest, although there is an
almost equal tendency to look over the whole sweep of the wave and the boats which are shooting through. The Japanese signature also proved interesting enough to draw the eyes to the upper left corner. The direction of eye movements in this picture, as will be indicated in individual plates shown later, presents even more striking evidence of the character of perception than does the distribution of fixations in this density plot.

Plate XII shows the combined records for 74 subjects who made a total of 4,060 fixations in looking at Picture 1, “Mt. Equinox, Winter.” The sky and the immediate foreground received less attention than do the more darkly shaded mountains. The two deer, which show faintly, attracted more than ordinary attention, but the spread of fixations is so general that the characteristics of the subjects’ perception can be indicated more clearly by statistical analysis than by mere observation of the density plot.

Plate XIII shows the massing of fixations for 42 subjects in looking at Picture 32, “Amazon.” As would be expected, the figure on the horse and the horse itself are the chief centers of interest. A large part of the fixations on the pedestal were initial fixations, the center of interest shifting rapidly to the upper part of the picture. The fixations cover rather completely the figure of the Amazon and the horse.

The distribution of fixations in the density plots which have been commented upon in the foregoing paragraphs is quite typical of that which occurred for other pictures in the series. The positions of the fixations indicate clearly that for certain pictures the center or centers of attention are much more limited than in other pictures. The fact that the density plots represent composite diagrams from a great many different subjects obviously results in a wider distribution of fixations on account of the varied interests of different individuals in looking at the same picture. However, the density plots do give a rather clear indication as to what parts of a given picture are likely to prove most interesting to a random selection of subjects.

**COMPARISON OF INITIAL AND FINAL FIXATIONS**

The character of the pattern of perception in looking at a picture changes rapidly from the initial to the later fixations. The nature of this change varies considerably from subject to subject and from picture to picture, but there are certain rather general characteristics which can be identified. Although, as would be expected, individuals differ consider-
ably as to what interests them most in a given picture, there are certain characteristics of perception which seem to be quite common to groups of subjects. Some analysis will be required to make these similarities clear.

One method of noting the progression from early to later fixations is to compare the location of the first few fixations with the location of an equal number of fixations made just before the subject stopped looking at a picture. An example of this difference is shown in Plates XIV and XV, which exhibit respectively the initial three fixations for forty subjects and the final three fixations for the same group of forty subjects in looking at Picture 13, "The Wave." As may be seen from Plate XIV, there is a great deal of concentration of the initial fixations, the main interest being the massive wave which predominates in the picture. In Plate XV, showing the last three fixations, there is much more diversification with an apparent interest in a variety of details. The boat sliding down the wave in the right fourth of the picture gets little attention during the first three fixations but a considerable amount of it in the last three. The snow-capped mountain gets notably more attention in the later fixations than in the earlier ones. The area around the inscription in the upper left corner receives little attention during the first three fixations, but considerably more during the last three; and the same tendency is apparent for that portion of the sea in the lower left part of the picture. While certain outstanding characteristics of initial and later fixations are indicated in Plates XIV and XV, the nature of the difference can be shown in much greater detail by simple statistical analysis.

If, for purposes of statistical comparison, a given picture were divided into sixteen equal rectangles, a study could then be made of the number of fixations falling within each small portion of the picture. Such a method of dividing a picture into rectangles is obviously arbitrary and artificial, but it serves the purpose fairly well. Plate XVI indicates this method of division for Picture 9, "Stowing the Sail." In Plate XVI the numbers in the upper left corner of each rectangle are placed consecutively in the sixteen parts of the picture merely for purposes of identification. In all subsequent plates of this type the numbering of the rectangles will be the same. The number which appears in the circle in each rectangle gives the percentage of the total number of fixations for the entire group of subjects, 68 in the case of Plate XVI. The two numbers separated by a dash in the lower part of each rectangle give, respectively, the percentage of the
first three and the last three fixations in that rectangle. For example, the 68 subjects who looked at Picture 9 made 16.6 per cent of their fixations in Rectangle 6, while in Rectangles 11 and 7 they made, respectively, 15.4 per cent and 14.7 per cent of their fixations.

Before proceeding to a general discussion of the distribution of fixations in the 16 rectangles it will be interesting to follow the consecutive fixations of that group of 35 subjects whose initial fixations fell in Rectangles 6 and 10 for Picture 9. The question is, "To what extent do subjects whose initial fixations fall in the same general area of a picture continue to show a similarity of interest as judged by the positions of successive fixations?"

Figure 1 shows the distribution of the first 5 consecutive fixations of this group of 35 subjects. Each of the 5 sections of Figure 1 contains 16 rectangles which correspond in position to those in Plate XVI. The first section shows the 33 first fixations of this group of subjects in Rectangles 6 and 10.

For the second fixations it may be seen that 10 of the 35 fixations have moved to Rectangle 5, 8 are still in Rectangle 6, 2 have moved to Rectangle 7, 1 has moved to Rectangle 9, 6 remain in Rectangle 10, and 8 have moved to Rectangle 11. The third fixations occupy the same set of rectangles as did the second fixations, but are arranged somewhat differently. By the fourth fixation these original 35 subjects had spread over a much larger part of the picture. One fixation is in Rectangle 1, 7 are in Rectangle 5, 5 are in Rectangle 6, etc., as indicated in the figure. By the fifth fixation there is still more diversification in the positions of the 35 fixations. It is clear from the movement for this particular picture that no single pattern of perception is followed by these 35 individuals. In this respect the behavior of this particular group is quite typical of that which could be illustrated from other pictures and other groups of subjects.

Comparison of initial and final fixations for Picture 9 may be noted by referring to Plate XVI on page 30. In this plate the first of the two numbers which appear in the lower part of each of the rectangles indicates the percentage of the first three fixations for the total group of 68 subjects which fall in that particular area. The second figure represents the percentage of the last three fixations for the same group of subjects. For the lower portion of the picture, as shown in Rectangles 13–16, inclusive, it is apparent that more attention was given during the last three fixations than during the first three. In Rectangle 13 there were no fixations during the first three, but 5.4 per cent of all the last three fixations fell in that
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Fig. 1.—Distribution of first five consecutive fixations for thirty-five subjects whose initial fixations fell in Rectangles 6 and 10. (Picture 9.)

In Rectangle 14 there was a slight increase from first three to last three fixations, a somewhat greater increase in Rectangle 15, and an increase from 0 to 2.9 per cent in Rectangle 16. In Rectangle 12 there was a marked increase, none of the initial fixations falling in that area, but 7.8 per cent of the final fixations falling there. Likewise, in Rectangle 11 the increase was from 11.8 to 17.6 per cent. In Rectangles 5, 6, 7, and 10 a greater amount of attention was given during the early fixations than during the later ones. These were the rectangles which attracted the eyes most often for the initial fixation, but in the subsequent observation of the picture the perception spread to other parts.

The numbers in the circles in Plate XVI, which indicate the percentage of fixations in each rectangle for the first 18 fixations during which the 68 subjects looked at the picture, give perhaps the best general index of interest value for the various parts of the picture. These percentages are based upon a total of 1,224 fixations, a number large enough to furnish a significant sample. The first 18 fixations were selected arbitrarily as a sample in order to give every subject equal weight in the percentages. Otherwise the variations in the total period of observation would attach unequal weights to the various subjects. However, the grouping of fixations designated as the "last three" refers to the last three for the entire observation of the picture, not the last three of the sample group of 18 fixations.

Plate XVII shows the percentage of fixations in the 16 rectangles for Picture 13, "The Wave." The statistical data upon which the percentages in this plate are based are shown in Table I, in which the number of fixations for the 40 subjects looking at this picture are given first for each of the first 18 fixations both by rectangles and by combinations of rectangles which divide the total picture into fourths instead of sixteenths. Following the presentation of the data for the first 18 fixations separately, the same numbers are recombined into groups of three fixations, giving the number of fixations in each of the sixteen rectangles and in each of the fourths of the picture. At the bottom of the table the data are recomputed in percentages, showing, first, the percentage of all 18 fixations in each of the divisions of the picture, then the percentage of the first three fixations, and finally the percentage of the last three fixations distributed in like manner. Complete tables similar to this were prepared for fifteen different pictures. Due to the limitations of space they are not reproduced here.
but a summary table giving the percentage distribution in the sixteen rectangles is given in Table II.

In referring to Plate XVII and Table I a very significant fact may be seen. For the first fixation the rectangles receiving the greatest amount of attention were Rectangles 15 and 10; nine fixations appearing in each. On the second fixation Rectangles 10 and 6 were the chief centers of interest. For the third fixation Rectangle 6 received the most attention, and for the fourth and fifth fixations the centers of interest were respectively Rectangles 6 and 2. The general direction of this major movement will be seen to follow the main direction of the wave, starting at the bottom in Rectangles 13 and 10 and then moving up through Rectangles 10 and 6 to Rectangle 2. The general direction of this movement is even more ap-
parent in the individual plottings for this picture, as will be shown later in this report.

A comparison of the percentage of the first three and the last three fixations also furnishes some interesting facts. Rectangle 6, which received 26.7 per cent of the first three fixations, received only 15.8 per cent of the last three. Likewise, Rectangle 10, which received 20 per cent of the first three fixations, received only 7.5 per cent of the final three. On the other hand, Rectangle 12, which received no attention during the initial fixations, received 10.8 per cent of the final fixations, and Rectangle 1, which received 39.9 per cent of all the fixations, attracted the eye, which immediately shifted to the upper part of the statue. Sixty-one and one-tenth per cent of the last three fixations fell in Rectangles 1 and 2, and 12 per cent of the first three fixations were distributed over that part of it, there being little to draw the attention to that portion of the picture except the sky and the beginning of the large wave.

When Picture 13 is divided into fourths, as one might anticipate, the center four rectangles receive the greatest amount of attention, 43.7 per cent of all of the fixations appearing there. The four rectangles in the upper left of the picture received 36.4 per cent and those in the upper right 9.1 per cent of the fixations; whereas the lower left fourth of the picture received 21.1 per cent and the lower right fourth 33.4 per cent of the fixations. The upper right quarter of the picture is clearly less attractive than the remaining parts of it, there being little to draw the attention to that portion of the picture except the sky and the beginning of the large wave.

Plate XVIII shows the distribution of attention for Picture 32, "Amazon." This picture is particularly interesting in view of the fact that the pedestal occupies almost exactly the lower half of the picture. Comparing the initial and the final fixations, it is apparent that while not a single one of the last three fixations was given to the lower half of the picture, 20.9 per cent of the first three fixations were distributed over that part of it. Still more striking is the fact that 45.8 per cent of the first fixations for this group of 24 subjects fell on the lower half of the picture. The large dark mass of the pedestal attracted the eye, which immediately shifted to the upper part of the statue. Sixty-one and one-tenth per cent of the last three fixations fell in the upper half of the picture, 19.9 per cent of the first three fixations were distributed over that part of it. It is interesting to note that 58.7 per cent of all the fixations are given to the upper half of the picture except the sky and the beginning of the large wave.
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**DISTRIBUTION OF FIXATIONS IN PERCENTAGES FOR TWENTY-FOUR SUBJECTS IN LOOKING AT PICTURE 32**
This is probably due to the human faces which, not only in this picture but in all others where they appear, prove to be principal centers of interest. The number of fixations in the right fourth of the picture, Rectangles 4, 8, 12, and 16, builds up very slowly, the number for each successive group of three fixations being 1, 7, 12, 18, and 20.

In looking at Picture 47, as shown in Plate XX, the fifty-nine subjects made a preponderance of their initial three fixations in the center four rectangles, 68.4 per cent of the fixations being located in that area. However, there was an increasing tendency to move toward the outer part of the picture, the total number of fixations in the center four rectangles being, for the successive groups of three, 122, 84, 82, 61, 52, and 54. In this picture there is also a marked tendency for fixations in the right fourth of the picture to increase, the number of fixations by successive groups of three in Rectangles 4, 8, 12, and 16 being 0, 7, 11, 19, 26, and 27. The column of rectangles on the left also shows an increasing number of fixations by groups of three, although not quite so pronounced as in the right tier of rectangles.

Plate XXI, which exhibits Picture 36, a tapestry, is of interest because the great amount of detail is much more widespread than in the case of some of the pictures already shown. While the center four rectangles receive the largest amount of attention, it is interesting to note how much more attention is given to the top row of four rectangles than to the bottom row.

Plate XXII, showing Picture 8, an abstraction entitled "Le Roi et la Reine," is introduced because of the radically different character of the composition. Most subjects expressed a good deal of doubt as to whether they saw anything in the picture or not. Only those subjects who were trained in art—and a relatively small percentage of them—showed any notable enthusiasm for the picture. The center and upper center rectangles received the greatest amount of attention, with the outer columns of rectangles on both the right and the left showing an increased amount in successive fixations.

The general statistical summary of the first eighteen fixations for each of the pictures treated was given in Table II on page 36. From this table it is clear that there is no single tendency which is characteristic of all of the pictures. The center four rectangles, which are numbered 6, 7, 10, and 11, received the greatest amount of attention, their respective percentages
**PLATE XXI**

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<td>8.</td>
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<td>5.7</td>
<td>13.0</td>
<td>16.3</td>
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<tr>
<td>2.3-6.9</td>
<td>16.1-17.2</td>
<td>19.5-6.9</td>
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<td>9.</td>
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<td>3.6</td>
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<td>0-2.3</td>
<td>10.3-10.3</td>
<td>16.1-11.5</td>
<td>1.2-9.2</td>
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<td>13.</td>
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<td>2.3</td>
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<td>1.2-3.5</td>
<td>6.9-1.2</td>
<td>2.3-9</td>
<td>0-5.8</td>
</tr>
</tbody>
</table>

*Distribution of Fixations in Percentages for Thirty-Four Subjects in Looking at Picture 30*

*Distribution of Fixations in Percentages for Twenty-Nine Subjects in Looking at Picture 8*
of fixations being 12.9, 13.3, 10.7, and 10.1. The two center rectangles at the top, numbered 2 and 3, received respectively 7.6 and 10.3 per cent of all of the fixations, while the rectangles in the corresponding position at the bottom of the picture received but 4.9 and 5.9 per cent of the fixations respectively. However, the center rectangles in the lower and upper rows received more attention than the center rectangles in the outer left and outer right columns. The total percentage of fixations given to the upper and lower center rectangles is 28.7 per cent, whereas the corresponding percentage for Rectangles 5, 9, 8, and 12 is but 15 per cent. For the four corner rectangles, numbered 1, 4, 13, and 16, the respective percentages are 1.8, 3.1, 1.6, and 2.8. The corners at the right received more than those at the left and the corners at the top more than the corners at the bottom. However, there is marked variation from picture to picture and it must be kept in mind that the averages for this group are influenced by the characteristics of the particular pictures included. However, with due attention to those features, the table furnishes some very significant data for artists to reflect upon.

It is interesting to note that the percentage of fixations in each of the sixteen rectangles for Picture 8, the abstraction, differs from the percentages in the various rectangles for the entire group of pictures by an average deviation of only 1.6 per cent. The greatest deviation in any single rectangle is 4.3 per cent, whereas in six of the rectangles it is less than 1 per cent. This may or may not be simply a matter of chance.

In looking at Picture 12, "The Solemn Pledge," the principal centers of interest are the four faces of the Indians. In this case comparing the distribution of fixations by rectangles is not particularly satisfactory because the lines dividing the rectangles arbitrarily cut across some natural centers of interest. When the heads of the four Indians are outlined in ink the number of fixations falling within the outlines can be ascertained. This was done, drawing the lines closely around the head of each of the two lower Indians, while for the two upper Indians whose heads overlap in the picture a single outline was drawn around both. Counting the first three fixations only for a group of 29 subjects, it was found that 26.4 per cent of the first three fixations centered on the heads of the two Indians near the top of the picture, 5.7 per cent of the same three fixations were on the head of the Indian at the lower left, whereas the head of the boy attracted none of the initial three fixations. For the entire number of fixa-

Centers of Interest

The two center rectangles for Picture 8, the abstraction, are some limitations to the interpretations which can be made for the four heads in Picture 11, "The Judgment of Paris." For the entire group of 17 subjects who looked at this picture, 15 per cent of the fixations fell directly on the four heads. The two heads in the middle attracted more attention than the two heads at either extreme.

Another study of fixations on a specific area of interest can be made for Picture 9, "Stowing the Sail." In this picture an outline was made leaving a three-millimeter border around the red flag hanging in front of the mast of the boat. For the entire group of 63 subjects there were only 57 fixations out of a total of 2,989, or 1.9 per cent, which fell within the area on and adjacent to the flag. For a test group of 22 subjects for whom the first three fixations were studied, only one fixation out of 66 fell on that area. While the red flag in this picture is frequently regarded as a striking center of interest, the objective data do not support this conclusion. As a matter of fact, it attracts little attention at the beginning of looking at the picture and receives a very small percentage of the fixations during the entire process.

Individual Patterns of Perception

In the foregoing sections of this chapter certain general characteristics of the process of perception in looking at pictures have been pointed out by means of density plots and by a statistical treatment of the positions of fixations in the sixteen rectangular subdivisions of the pictures. There are some limitations to the interpretations which can be drawn from massing data in this manner, due to the fact that certain characteristics of a pattern of perception for one individual may counterbalance opposite tendencies with another individual and thereby cover up significant features of the perceptual process. In this section of the chapter a series of individual records will be shown in which the actual patterns of perception are presented with objectivity and precision. As was stated in an earlier
part of this report, 1,877 individual records were secured. It is obviously impossible, due to limitations of space, to present even a considerable sample of this large number of records. In selecting individual records for presentation the writer has tried to select those which are most typical of the main group of subjects, or which illustrate certain features to which particular attention is to be called. The plottings which follow are not to be thought of simply as pictures used to illustrate this report. The dots and lines on the prints of the pictures are the actual data in a study of this type, and they show the characteristics of perception more vividly than do verbal descriptions or statistical tables.

Plate XXIII shows the eye-movement record of Subject 1 in looking at Picture 3, "Joan of Arc at the Court of Charles VII." The border around the picture received no direct fixations whatever. The pattern of perception begins at the left center of the picture. Fixations 1-8 make a general swing across the faces of the group of standing figures and then go to the kneeling figure in the center. Fixations 9-14 cover this kneeling figure. Beginning with Fixation 15 there is another swing back and forth over the faces of the group, and then beginning with Fixation 27 and extending through Fixation 37 the attention is given to the costumes of the figures on the right. Fixations 38-46 again cluster around the kneeling figure, while Fixations 47-54 cover the rather elaborate costumes of the figures at the left of the picture. The subject returns again to the center of the picture for the last three fixations. The outstanding characteristics of this pattern of perception are the swings of the eye across the faces of the standing figures, the detailed examination of the kneeling figure, and the two periods of examination of the costumes, first at the right and then at the left. The duration of the fixation pauses is given in the tabulation of figures below the plate. It will be seen that the fixations range in duration from 3 thirtieths of a second on Fixation 4 to 82 thirtieths of a second on Fixation 58. A discussion of the reasons for this variation in duration of fixations will be reserved for chapter iii, which is concerned explicitly with that problem. However, the variation in the duration of the fixations is very large and obviously reflects the adjustment of the eye to the different interests of the subject in looking at the picture. The reader should bear in mind that the total number of fixations reflects either the termination of the subject's desire to continue looking at the particular picture or the arbitrary cutting off of the picture if the number of fixations gets to be too
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large to be plotted clearly on a single print. Ordinarily, it is difficult to
plot more than 75 fixations on one picture without having the lines and
dots become so confused that it is impossible to follow them. In the case
of this particular picture the subject signaled of his own accord for the
next picture to be shown.

Plates XXIV and XXV show the records of two subjects in looking at
Picture 6, “Sunday on La Grande-Jatte.” In Plate XXIV the subject
signaled for a change of pictures at the end of the forty-second fixation,
while in Plate XXV the subject made a longer study covering a total of
126 fixations. The general pattern of perception in Plate XXIV can be
followed easily. The first fixation falls almost exactly in the center of the
picture and the eye then moved to the head of the lady carrying the para-
sol. Following Fixation 3 the center of attention moved to the figures
sitting on the grass in the lower left of the picture. Beginning with Fixa-
tion 12 there is a general sweep to the left and then over the upper portion
of the picture, swinging back to the standing figures with the parasol and
then continuing the survey down toward the lower part of the picture.
The duration of the fixations shows much less fluctuation than was found
for the picture described in the preceding paragraph. In this case the
range is from 2 thirtieths of a second on Fixation 32 to a duration of 25
thirtieths on Fixation 29.

Plate XXV presents a much more elaborate examination of the picture.
No attempt will be made here to describe the pattern in detail, but the
serial numbers on the dots and lines can be traced easily, starting with the
first fixation which falls slightly to the left and above the center of the
picture. The parts of the picture which received most attention from this
subject are the man and lady carrying the parasol, the figures in the upper
central portion of the picture, the figures at the extreme left, and the group
on the grass in the lower left portion of the picture. The location of the
fixations reveals considerable attention to details, as, for example, Fixa-
tions 48, 49, and 117 on the small dog. Fixations 75 and 116 on the large
dog, and clusters of fixations over particular individuals. The variation in
duration of the fixations, as shown in the numbers below the picture, is
somewhat greater than in Plate XXIV, being from 2 thirtieths of a second
on Fixation 45 to 50 thirtieths of a second on Fixation 29.

A picture of somewhat different character is shown in Plates XXVI,
XXVII, and XXVIII. In this picture, “The Grief of the Pasha,” special
centers of interest are the dead tiger lying on the rug, the Pasha sitting at the side, and the elaborate decorations above the pillars. The initial fixation occurs directly on the tiger. Fixations 1–6 make a general survey of his body. Fixations 7–13 shift to the two large burning candles. The subject then moved his eyes to the Pasha, shifted once more to the tiger, and finally, beginning with Fixation 26, started an elaborate and detailed survey of the decorations in the upper part of the room. Little attention is given in Plate XXVI to the central and left parts of the picture.

In Plate XXVII, on the other hand, a rather detailed examination is made of the left part of the picture. This subject gave a large amount of attention to the tiger, a considerable amount to the sitting figure of the Pasha, and a somewhat different type of attention to the architectural features of the room. The repeated swings of the eye back and forth from left to right make a conspicuous characteristic of this pattern of perception. One group of four consecutive fixations, namely, Fixations 30–33, are much longer in duration than most of the others. It is interesting to note that this group of fixations is centered around the figure of the Pasha. Fixations 100 and 101 are longer than normal and these two fall directly over the head of the tiger. The hypothesis may be suggested here and the treatment of it reserved for chapter iii, that a group of fixations of longer than average duration may indicate a position of special interest to the subject and that the mental processes going on at that time may partake more of mental reflection than of the simple characteristics of visual perception.

Plate XXVIII shows a still different pattern of perception than the two just described. In this case a relatively small amount of attention goes to the tiger, very little to the figure of the sitting Pasha, but a very large amount to the burning candle at the left and to the architectural decorations at the top of the room. The numerous short eye movements from fixation to fixation in the upper part of the picture indicate a detailed examination of the decorations such as was not apparent in either of the other two plates for this same picture. A comparison of the three subjects whose records are shown in Plates XXVI – XXVIII illustrates the statement made earlier in this chapter to the effect that the density plots showing combined records for a large group of individuals are useful in identifying main centers of interest but that individual traits may thereby be lost. The distinctive characteristics of perception in these three plates would certainly be lost by combining them.
Plate XXIX, which exhibits one subject’s fixations on Picture 36, a tapestry, is of interest because the picture contains so much detail and because almost every section of the tapestry has some attractive features. Subject 9 begins at the left center, the first series of fixations moving to the lower right part of the picture. From there, beginning with Fixation 6, the eye moves toward the upper part of the picture and makes a general survey ending with Fixation 16 in the upper right corner. The pattern of perception for this individual is characterized by a series of large swinging movements of the eye. The series, beginning with Fixation 34, makes a complete swing around the outer part of the tapestry ending with Fixation 32. There is no evidence at any point in this plate of a detailed examination of a single portion of the tapestry. If this subject had looked at the picture continuously for several minutes probably such detailed examination would have occurred later on. The pattern of eye movements here is typical of that found in the case of a great many subjects where the process of looking at a picture consisted simply of a general survey of its major features. Many subjects signaled that they were through looking at the picture and ready for the next picture at the end of this general survey, showing no particular desire to continue to a detailed study of the picture. Their behavior resembles that so commonly witnessed in an art gallery where individuals move rapidly from picture to picture with a superficial perception of each. However, for other subjects quite the reverse was true, their patterns of fixations showing numerous centers where clusters of eye movements around a particular item of interest reveal a detailed examination of that part of the picture.

Plates XXX and XXXI for Picture 10, “The Silence of the Night,” are of interest because of certain characteristics of the picture itself. A priori one might expect to find many eye movements in the vertical direction following the lines of the trunks of the birch trees. In Plate XXX there is considerable evidence that the white trunks of the trees did influence the general pattern of perception. The fixations for this subject fall into three distinct groups arranged around the three clusters of birch trees, first at the left, then in the center, and then at the right. There is no general swing of the eyes from left to right across the picture until Fixation 30, after which the eye moves back to the trees at the left.

In Plate XXXI, on the other hand, there is much less evidence that the vertical lines of the tree trunks influenced the pattern of perception. Here
the horizontal movements are much more predominant than the vertical ones. With the exception of certain vertical movements at the left of the picture, following the line of the tree trunk, there is little indication that the trunks of the trees were followed at all. On the other hand, there is a great deal of horizontal movement both at the top of the picture, back and forth from the tree tops and clouds, and in the lower central parts of the picture following the general features of the landscape. The cluster of fixations in the right center over the end of the road indicates a particular interest in that section. Also, there are evidences of considerable interest in the lower left and in the lower central parts of the picture. The large number of short fixations, particularly in the first half of the record, may surprise the reader. One might expect for a picture of this type that long fixations and more reflection would be characteristic. In the latter half of the picture there are more long fixations although none of any extreme duration, 33 thirty-thirds of a second being the longest single fixation in the entire record. The picture had the title “The Silence of the Night” printed below it as shown in the plate. This subject paid no attention whatever to the title and made no fixations remotely approaching it. For the entire group of subjects whose records were taken with this picture, 27 per cent looked at the title while 73 per cent did not.

Two individual records for Picture 13, “The Wave,” are shown in Plates XXXII and XXXIII. In Plate XXXII general circular movements following the direction of the wave are clearly apparent. The first fixation falls slightly above and to the left of the center. The movement then proceeds to the top of the big wave, swings over to the left, and then in a left-to-right movement it swings down through the wave and up again at the right to the sky, changing direction with Fixation 13. Following Fixation 13 the eye moves again in a circular motion first down to Fixations 14 and 15 and then in a left and upward direction, following the general swing of the wave to its crest in Fixations 29 and 30. The whole pattern of fixations here is dominated by the tremendous pull of the movement of the wave. The dim print of the picture, as shown in the plate, loses much of the detail which appears in the large colored print shown to the subject. The manner in which this particular subject looked at the picture furnishes an excellent example of how an artist is able to control the perceptual process by the composition of his picture. Subject 142, whose record is shown in Plate XXXIII, exhibits a general tendency of
movement from the lower right to the upper left although the circular swings of the eye are not so pronounced as in the case of the subject shown in Plate XXXII. Subject 142 was evidently more interested in detail than in the direction of the wave, more attention being given to the boat gliding down the wave at the right, to the snow-capped mountain, and to the boat coming out from behind the small wave. Some attention was also given to the Japanese inscription in the upper left corner. The writer regrets that it is impossible to show here the entire set of forty plottings for the group of subjects whose records were obtained for this picture. A survey of a large group of individual records shown together is much more illuminating than a display of one or two sample cases can be.

Plate XXXIV, which shows a photograph of the statue, “Joan of Arc,” Picture 31, presents a quite different situation than the pictures which have been shown heretofore. The background in this case contains nothing at all of interest. Consequently, it is not surprising that the entire process of perception is limited to the kneeling figure and the base on which it rests. The face receives a large amount of attention, as might be expected, as do also the folded hands. The face and the hands were the principal centers of interest for most of the subjects who looked at this picture. The patterns of perception in general showed a wider spread over the lower part of the figure, narrowing to the face at the top, as is the case in this particular plate.

Three records are shown for Picture 12, “The Solemn Pledge,” in order to illustrate three definite characteristics of the group of subjects who looked at this picture. Plate XXXV shows a record which is typical of a number of others. Here the four faces constituted practically the entire subject of interest, very little attention being given to any other part of the picture. The only exception to the concentration on the four faces was a series of six fixations centering around the boy’s hand in the lower central part of the picture. Whatever effort the artist spent upon the background was lost for this particular subject as far as any direct observation was concerned. The typical characteristic here is the close attention given to the four faces, the movement being from the two faces at the top to the one at the left and then to the one at the bottom, back to the left and to the top. In only one instance, namely, the movement from Fixation 59 to 60, was there a movement from the two faces at the top directly to the face of the boy in the lower right corner. In Plate XXXVI there is again a
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predominance of interest in the faces of the Indians. However, there is somewhat more diversion of attention, several fixations spreading to the sky and landscape at the top and at the left side of the picture. The faces of the tall Indian at the top and the Indian at the left dominate the interest of this particular subject. Plate XXXVII is shown because, while it is not typical for a large group of subjects, there were several records such as this. Here there is a decided lack of a dominant interest in the faces of the four Indians, the major attention going to the background. The principal movements of the eyes are around the two sides and across the top of the picture, there being six large swings of the eyes directly across the picture in horizontal direction. This particular subject was a high-school senior, as was also the subject shown in Plate XXXVI. The subject shown in Plate XXXV was an adult.

In books dealing with art one frequently encounters the statement that vertical lines such as those appearing in the picture of the cathedral interior, Picture 47, have a tendency to lead the eye in an upward direction and to cause a predominance of vertical eye movements. Plates XXXVIII, XXXIX, and XL show the records of three subjects in looking at Picture 47. Subject 77, shown in Plate XXXVIII, made his first fixation near the center of the picture and gave most of his attention to the vertical center of the picture. One predominant upward swing of the eyes is noted in Fixations 49-53, while, on the opposite side, a downward set of fixations appears, from Fixation 38-41, covering the column on that side of the picture. There is also a cluster of fixations in the lower left part of the picture. However, the major portion of attention is given to the window, the pipe organ, and the doors.

In Plate XXXIX, for Subject 66, there is still a considerable amount of study given to the vertical and central portion of the picture. However, there is much more attention to the columns on the two sides, the sweeps of the eye up and down these columns indicating the influence of the vertical lines.

A still different pattern of perception is shown in Plate XL, where the several clusters of eye fixations indicate detailed examination of certain portions of the picture. In the central part there is a cluster on the window, another on the pipe organ, one at the upper right corner of the picture, and quite a spread of fixations over the lower foreground. In this plate there is again evidence of several vertical sweeps of the eye, influ-
enced apparently by the general direction of vertical lines. In Plate XL there is a small cluster of fixations over the hanging flag in the upper left part of the picture, although for the subjects as a whole little attention was given to this particular item.

Picture 45, as shown in Plate XLI, shows an interior similar in certain respects to the cathedral shown in the preceding set of plates, but different in proportion, there being much more breadth and less height. The general impression of Picture 45 is a dominance of horizontal and low arched lines, whereas in Picture 47 the dominant characteristics were the tall pillars and the high vaulted ceiling. The movements of the eyes follow rather clearly the general directions of the lines in the interior of the library shown in Picture 45. Fixations 18–23 show a marked swing of the eyes following the general line of the shape of the room, whereas the flat tables in the lower part of the picture bring out horizontal movements. There is evidence of much detailed examination, although there are no specific clusters of fixations revealing a close study of any particular characteristic of the room.

A room of a still different type is shown in Plate XLII for Picture 46. In this empty colonial room the major characteristics are right angles and sharp lines. The reaction of the subject is somewhat different from that shown in the two preceding pictures. The influence of the squareness of the room, the fireplace, and the windows is apparent. There is no series of fixations curving from one point to another as in Picture 45, and there are no sweeping vertical lines as in Picture 47. There are more right angles in the movements of the eye and a general following of the contour of the room, as in Fixations 5–13, following the ceiling line, and in Fixations 37 and 38 and 47–52, following the floor line. The left window received a considerable amount of attention and the main lines of the room were followed somewhat closely.

The nature of perception in looking at Picture 22 is revealed in Plates XLIII and XLIV. The influence of the general outline of the objects is clear in both of these plates. In Plate XLIII the fixations start near the center of the wine cup, swing first to the lower left and then to the handle on the right. Following this the eyes made another complete swing to the center of the upper part of the wine cup and back to the handle, and then still a third general swing over the upper edge of the cup and back to the handle. Not until after this rather complete survey did the eye move to
the jar at the right side of the picture. In Plate XLIV the subject made a longer examination of the two objects. The general swing of the eyes, however, in outlining the pattern of the wine cup is again clearly evidenced. In the case of Subject 1 in Plate XLIV the eyes swung completely from one handle of the cup to the other, whereas in the case of Subject 12, Plate XLIII, the left handle of the cup received no direct observation whatever. In Plate XLIV the subject passed back and forth from one object to the other several times, indicating possibly some comparison of the two. It is also interesting to note that in looking at the wine cup the movements of the eyes are primarily in the horizontal direction, whereas in looking at the jar the movements are chiefly in the vertical. The patterns of perception shown for these two subjects are quite typical of those which were found in the majority of cases in looking at this picture.

In looking at the elaborately decorated Chinese bronze jar, shown in Picture 21, the various patterns of perception were so interesting that the writer decided to sacrifice the easy legibility of the serial numbers of the fixations and the durations in order to present a set of eight plots. Consequently, for this picture four plots are presented on each page and, while the numbers may not be read easily without a reading glass, the general pattern of perception can be seen. No attempt will be made to comment individually upon each of the eight plottings. Certain general differences in pattern, however, are apparent. For example, in Plate XLVb the general pattern of perception is very different from that in XLVd. In Plate XLVb the fixations are confined for the most part to the central portion of the figure, the only exceptions being Fixations 17, 19, 20, and 21. However, in Plate XLVd the eye made a series of very conspicuous swings following the outer edge of the vase and up and down the central portions. Fixation 43 in the lower right corner starts a series of twenty-two fixations which circle the entire figure ending with Fixation 64. Plate XLVa shows three particular centers of interest, one at the upper part of the handle, which is a tiger mask, and the other two centers in the upper center and center portions of the vase. In most of the figures the darker portions down the center of the vase and the darker portions around the outside edges received more attention than the two light sections extending up and down the vase. This is undoubtedly due to the fact that the reflection of light in these latter parts of the picture obliterates the delicacy of design which makes the vase of particular interest. The four plottings shown in Plate XLVI show other types of perceptual patterns.
The entire series of individual plots which has been shown in the foregoing pages of this chapter indicate the nature of the perceptual process better than could be done by verbal generalizations. Individual differences from subject to subject seem to be somewhat more striking than likenesses in perceptual pattern. Still, there are certain general characteristics which can be noted, and, from a comparison of the actual process of perception with the characteristics of the picture, the artist may gain some knowledge as to the influence of certain types of pictures upon the perceptual process. The particular significance of these plates lies in the fact that the patterns of perception are entirely objective and that they show where the actual centers of attention were as the subject looked at the picture. A considerable number of hypothetical statements which are found in the literature of art, such as those quoted in chapter i, may be verified or shown to be incorrect by reference to the patterns of perception which are obtained by the photographic method. An example showing the relation of the data of this study to one of these hypothetical assumptions is presented in the following paragraphs.

It is commonly assumed that the eye will follow the direction of the principal lines in a picture. If the principal lines extend in a vertical direction the eye movements are assumed to be mainly vertical. On the other hand, if the picture emphasizes horizontal lines the direction of the eye movements is assumed to accord with the direction of the lines. In order to test this assumption a special study has been made of the initial fixations for three pictures: first, Picture 47, a cathedral interior in which the main direction of the lines is pronouncedly vertical; second, Picture 13, "The Wave," in which the principal lines follow the direction of the wave; and third, Picture 45, the library of the Oriental Institute, in which the breadth of the room approximates its height and, while the lines of the ceiling extend vertically, their horizontal spread is almost equally great.

Table III shows a comparison of the amount and direction of movements from Fixation 1 to 2 and from Fixation 2 to 3 for groups of subjects looking at these three pictures. The method of measuring the amount of movement was to compute by means of a square the horizontal distance and the vertical distance between Fixation 1 and Fixation 2 and then to secure the same type of measurement for the distance from Fixation 2 to Fixation 3. The distances were measured in millimeters and were recorded in terms of the amount of movement up, down, to the left, or to the right.
For Picture 47 there were 59 subjects for whom measurements were made. Reading from Table III, it may be seen that for this group of 59 subjects the average movement per subject from the first fixation to the second was 14.5 millimeters in the upward direction, that the average movement in the downward direction was 17.4 millimeters, whereas the corresponding movements to the left and to the right were 3.3 and 6.1 millimeters respectively. Adding the total vertical movements up and down and also the total horizontal movements, it is found that the average amount of vertical movement is 31.9 millimeters, whereas the average horizontal movement is 0.4 millimeters. It is perfectly clear from these readings that the total horizontal movement being 17.8 millimeters. Likewise, in the case of Picture 13, "The Wave," an analysis of the direction of movements between the first and second and the second and third fixations again reveals some striking facts. The movement from Fixation 1 to 2 is somewhat more pronounced in the vertical direction than in the horizontal direction, but in the vertical direction in this case practically all the movement is up and very little of it down. To be specific, the average movement in the upward direction from Fixation 1 to 2 is 26.2 millimeters, whereas the average movement in the downward direction is 0.8 millimeters. It is perfectly clear that, in the initial observation of this picture, the eye movements are pronouncedly affected by the main direction of the large wave which is moving up. From Fixation 2 to 3 there is still a predominance of upward movement although not quite so pronounced as in the case of the movement from Fixation 1 to 2. The predominance of upward rather than downward movements from Fixation 1 to 2 is revealed not only in the average movement in millimeters, but also by the number of movements in that direction. Thirty-five of the 37 subjects moved their eyes in the upward direction from Fixation 1 to 2, whereas only 2 subjects moved their eyes in the downward direction. In a number of respects Picture 13 furnishes an excellent illustration of how an artist has succeeded in controlling the pattern of perception by the characteristics of his picture.

For Picture 45, as indicated in Table III, there is a little more movement in the vertical direction than in the horizontal direction from Fixation 1 to 2, but for Fixation 2 to 3 the amount of movement is nearly equal, the total vertical movement being 17.3 millimeters and the total horizontal movement 17.8 millimeters. Likewise, in the movements of Fixation 1 to...
2 there is a little preponderance of upward rather than downward movements, the amounts in the two cases being 9.3 and 8.7 millimeters respectively. For the movements for Fixation 2 to 3 there is a greater predominance of upward movement than downward movement, the measurement being 12.0 and 5.3 millimeters.

The data for the three pictures, as presented in Table III, are quite in accord with the common expectations in regard to horizontal and vertical eye movements. The cathedral interior with its great predominance of vertical lines reveals a predominance of eye movements in that direction. The wave picture with the marked swing of the major wave upward and to the left shows corresponding effects on the eye movements. In the picture of the library interior where the relations of vertical to horizontal lines are less pronounced, the eye movements are less different in respect to vertical and horizontal direction. These three pictures have been selected for this type of treatment due to the fact that the contrasts in vertical and horizontal lines furnish an interesting basis for comparison. Obviously, several other pictures in the total group of fifty-five might have been used in a similar fashion. A comparison of Picture 42 showing the tall church spire would show an equally interesting contrast with Picture 44 of the Rosenwald Museum in which the general direction of line is predominantly horizontal.

CHAPTER III

THE DURATION OF FIXATION PAUSES

It has been evident from the plates shown in chapter ii that the duration of a single fixation pause of the eye varies a great deal. Three thirtieths of a second may be considered as typical of the shortest fixation pauses, but at the other extreme there are fixations with durations of 40 or more thirtieths of a second. Approximately 5 per cent of the fixations are more than 20 thirtieths of a second in duration. These variations in duration are evidently related in some intimate fashion with the mental process of perception, since the movements and fixations of the eyes are simply the involuntary adjustments to this process. In the present chapter an attempt will be made to discover some of the reasons for variation in the duration of fixations.

The variation in duration of fixations for the process of reading has already been made the subject of considerable study. For example, it is known that as children become more mature in the process of reading, the duration of the fixation pauses becomes increasingly shorter. For children in the first grade an average duration of fixations for the silent reading of easy material is approximately 19 thirtieths of a second. By the time these children reach the high-school or college level and have become mature readers, the average duration of a fixation pause for the same type of reading material will have been reduced to approximately 6 thirtieths of a second. Furthermore, it is known that when particular difficulties are encountered in reading, such as difficulties in vocabulary, the duration of the fixation pauses increases. It is evident, therefore, that, in the practice of reading, a long fixation is in some manner related to difficulty in perception. The process of reading is, of course, very much more than the simple recognition of words. The words must be fused together into units of thought which are meaningful. The purpose of reading is to get ideas from the printed page. Consequently, difficulties, either in recognition of words or in grasp of the thought presented, have a marked effect upon the characteristics of eye movements and fixation pauses.

In looking at pictures the process of perception seems hardly compa-
rable with that in the case of reading. There is no evidence to indicate that children of school age see less well than adults or that the ordinary process of observation for them presents any more difficulty than it presents to adults. Furthermore, as will be shown later on in this report, the average duration of fixation pauses for children is little different from the average for adults in looking at the same pictures. Variations in duration of the fixation pauses cannot be thought of as indexes of difficulty in seeing the picture. Some other hypothesis, therefore, needs to be proposed.

A situation which suggests another hypothesis may be noted in the process of arithmetical addition. If an individual is given a column of digits to add and a photograph of the eye movements is taken as he proceeds either up or down the column, the variation in the duration of the fixation pauses will be very much greater than is found in reading or in looking at pictures. It is not uncommon in adding a column of digits to find single pauses of the eye which are as long as six or even eight full seconds. It is perfectly obvious that the ordinary process of perceiving what the digits are could not possibly occasion a fixation pause as long as this. The only remaining hypothesis in the case of addition is that the long durations do not appear because of any difficulty in visual perception, but rather because of central thought processes which cannot keep pace with the ordinary process of perception. Thus, when a person reaches a new combination which is difficult to add, the eye may hold perfectly still waiting for the mental process of adding to be completed. This hypothesis, for which there is available in the literature a very considerable amount of supporting data, suggests that a long fixation pause in arithmetic is indicative of a central thought process, whereas shorter fixations are the typical characteristics of normal visual perception where there are no particular thought difficulties involved.

If one would apply the hypothesis just described to the field of art, he might reason that the short fixation pauses are the typical procedure when the subject is simply looking at the picture, but that, when some particular portion of the picture so interests the observer that his mental process takes on the characteristics of reflection, the duration of the fixation pauses would become longer. If this hypothesis were correct one would expect the average duration of fixation pauses during the first observation of the picture to be considerably shorter than the average during the latter part of the observation. This would be expected due to the fact that in observing any new picture the first requirement of the attention is simply to see what is there, that is, to get information about it. After one has become aware of the characteristics of the picture, the processes of interpretation and reflection might be expected to occupy a greater part of his attention.

If the mental experiences which occur as a subject looks at a picture could be known, it would then be possible to correlate them directly with the objective record of the fixations of the eye. However, any record of the content of the mind must, in the very nature of the case, depend upon introspection from memory after the picture has been seen. The dangers of misinterpreting such subjective evidence are so great that the writer has chosen to make no attempt to deal with subjective accounts of mental experience in looking at pictures.

One might expect persons who have high ability in art to give more of their time to reflection and interpretation than would subjects who have less artistic ability. Adequate ratings of artistic ability are difficult to secure, but in chapter V of this report a comparison is made of the characteristics of subjects who ranked high and who ranked low on a test of artistic appreciation. As a part of that comparison, the study of durations is continued.

**Variations in Duration of Fixations by Subjects and by Pictures**

One method of studying variation in duration of fixations is to find the average duration of fixation pauses for a group of subjects each of whom has looked at the same group of pictures. The selection of data from those which are available would allow the use of a large group of subjects for a few pictures or a small group of subjects for a large number of pictures. The writer has chosen to take the middle course in both directions and accordingly there is presented, in Table IV, the average duration of fixation pauses for twenty-nine different subjects each of whom looked at the same nine pictures.

By reference to Table IV, one can see the variations in duration in terms of individual subjects for each picture separately and for all pictures together, or in terms of the entire group of subjects for each picture. Considering the latter variation first, it will be seen that the range of average duration of fixations for the various pictures was from 9.6 thirtieths of a second to 10.7 thirtieths of a second. The variation from picture to picture...
for the same group of subjects is quite small, the range being 1.1 thirtieths of a second. For individual subjects the range in average duration of fixations is somewhat greater. For example, Subject 63, the first one shown in the table, made an average fixation pause of 8.6 thirtieths of a second on Picture 2, but an average of 13.1 thirtieths on Picture 32. An inspection of the averages for individuals on each of the pictures throughout the table reveals a very large amount of variation of this sort. The picture which for one subject may produce long fixation pauses may, for another, result in short pauses. Furthermore, the range of average durations is very much greater for some subjects than for others. For example, Subject 80 showed a variation for the 9 pictures of from 6.6 thirtieths of a second for Picture 13 to 8.1 thirtieths on Picture 15, a range of only 1.5 thirtieths of a second. On the other hand, Subject 101 made an average duration of 8.4 thirtieths of a second on Picture 1, but an average of 17.1 thirtieths on Picture 47, a range of 8.7 thirtieths of a second.

### Table IV

**Average Duration of All Fixations for Twenty-Nine Subjects in Looking at Nine Pictures**

<table>
<thead>
<tr>
<th>Subject Number</th>
<th>Picture Number</th>
<th>Average of All Fixations</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>1  2  3  4  5</td>
<td>8.6 8.4 9.9 8.8 12.1 13.1 9.9 10.9 10.1</td>
</tr>
<tr>
<td>65</td>
<td>1  2  3  4  5</td>
<td>7.2 11.8 11.0 11.0 8.1 8.1 7.4 7.5 7.2 8.8</td>
</tr>
<tr>
<td>66</td>
<td>1  2  3  4  5</td>
<td>9.5 7.9 7.6 7.5 8.6 8.0 10.2 9.5 7.9 8.5</td>
</tr>
<tr>
<td>67</td>
<td>1  2  3  4  5</td>
<td>9.4 8.3 12.2 10.8 9.4 10.0 10.1 10.3 10.1 10.1</td>
</tr>
<tr>
<td>69</td>
<td>1  2  3  4  5</td>
<td>13.9 10.8 11.0 10.4 11.8 12.4 15.9 15.1 10.2 12.4</td>
</tr>
<tr>
<td>72</td>
<td>1  2  3  4  5</td>
<td>12.1 11.8 11.0 10.0 9.4 13.5 15.7 15.1 15.1 15.9</td>
</tr>
<tr>
<td>74</td>
<td>1  2  3  4  5</td>
<td>9.7 15.1 10.5 10.7 12.6 10.9 8.7 10.2 8.2 10.5</td>
</tr>
<tr>
<td>75</td>
<td>1  2  3  4  5</td>
<td>12.8 11.3 11.4 9.3 13.9 11.5 11.9 10.6 9.7 11.4</td>
</tr>
<tr>
<td>77</td>
<td>1  2  3  4  5</td>
<td>9.8 9.5 8.5 11.0 9.8 8.9 10.1 10.4 9.5 9.8</td>
</tr>
<tr>
<td>78</td>
<td>1  2  3  4  5</td>
<td>7.9 9.5 9.1 11.1 8.2 9.3 9.8 10.5 9.5 9.1</td>
</tr>
<tr>
<td>79</td>
<td>1  2  3  4  5</td>
<td>9.9 11.5 9.0 9.0 8.6 7.8 9.2 8.1 8.4 9.1</td>
</tr>
<tr>
<td>80</td>
<td>1  2  3  4  5</td>
<td>7.9 7.5 6.6 6.8 8.1 8.0 7.7 7.2 7.5 7.5</td>
</tr>
<tr>
<td>82</td>
<td>1  2  3  4  5</td>
<td>9.5 12.0 9.7 10.9 10.0 10.2 10.9 10.3 8.9 9.9</td>
</tr>
<tr>
<td>83</td>
<td>1  2  3  4  5</td>
<td>8.2 9.6 10.3 13.2 11.1 9.0 9.9 9.2 8.3 9.9</td>
</tr>
<tr>
<td>84</td>
<td>1  2  3  4  5</td>
<td>7.4 7.3 7.1 6.5 6.1 6.3 4.7 7.7 7.4 6.7</td>
</tr>
<tr>
<td>91</td>
<td>1  2  3  4  5</td>
<td>9.1 10.6 9.8 11.9 10.6 10.0 12.8 10.5 9.4 10.5</td>
</tr>
<tr>
<td>92</td>
<td>1  2  3  4  5</td>
<td>13.8 10.9 8.1 12.4 14.1 10.0 15.4 13.1 10.9 12.1</td>
</tr>
<tr>
<td>94</td>
<td>1  2  3  4  5</td>
<td>10.5 9.5 9.2 10.5 7.1 10.3 12.2 12.3 10.3 12.2</td>
</tr>
<tr>
<td>95</td>
<td>1  2  3  4  5</td>
<td>9.4 8.4 10.4 11.7 8.3 8.9 8.0 9.8 9.7 9.5</td>
</tr>
<tr>
<td>98</td>
<td>1  2  3  4  5</td>
<td>8.0 7.7 7.9 8.5 9.2 7.8 7.9 7.7 8.5 8.1</td>
</tr>
<tr>
<td>99</td>
<td>1  2  3  4  5</td>
<td>9.0 9.6 10.4 10.9 12.1 10.6 14.1 10.7 8.7 10.5</td>
</tr>
<tr>
<td>101</td>
<td>1  2  3  4  5</td>
<td>8.4 10.4 11.1 15.9 9.2 12.3 15.6 12.3 17.1 12.3</td>
</tr>
<tr>
<td>102</td>
<td>1  2  3  4  5</td>
<td>8.2 8.0 9.4 10.4 8.5 8.4 9.0 8.8 17.6 8.7</td>
</tr>
<tr>
<td>103</td>
<td>1  2  3  4  5</td>
<td>11.0 10.7 9.3 10.2 13.6 13.9 10.0 10.5 10.8 11.1</td>
</tr>
<tr>
<td>104</td>
<td>1  2  3  4  5</td>
<td>11.5 10.0 10.3 12.5 20.7 11.9 12.2 12.2 11.2 12.8</td>
</tr>
<tr>
<td>105</td>
<td>1  2  3  4  5</td>
<td>9.6 10.8 10.2 11.6 8.1 8.2 9.4 11.2 9.4 9.8</td>
</tr>
<tr>
<td>106</td>
<td>1  2  3  4  5</td>
<td>9.2 9.5 8.4 11.9 9.3 8.7 10.0 10.7 8.7 9.6</td>
</tr>
<tr>
<td>109</td>
<td>1  2  3  4  5</td>
<td>9.1 10.0 10.9 10.4 9.7 10.9 8.2 9.3 7.8 9.9</td>
</tr>
<tr>
<td>115</td>
<td>1  2  3  4  5</td>
<td>9.4 11.0 11.4 10.8 9.8 15.7 15.1 13.3 10.0 11.4</td>
</tr>
</tbody>
</table>

The column of digits at the extreme right of Table IV shows the average duration for each subject for the entire group of nine pictures. It will be seen that the range of variation from subject to subject for the entire group of pictures is very much greater than the range from picture to picture for the group of subjects. Subject 89 showed the shortest durations, the average for all the pictures being 6.7 thirtieths of a second. On the other hand, Subject 72 made an average of 12.9 thirtieths of a second for the entire group of pictures, which was the longest average duration in the group.

In order to secure a more thorough understanding of Table IV, it will be necessary to make a more refined analysis of the data. It has been suggested that the average duration of fixations might be expected to increase as one continues to look at a picture. In Table V a body of data is given for checking this hypothesis. This table includes all of the records of all of the subjects who looked at seven of the pictures. The pictures selected were those for which a large number of records were available. The
table gives the picture number, the total number of subjects for each picture, and then in successive columns the data relating to duration of fixations. The data are summarized at the bottom of the table, showing the averages for the entire group of pictures. From the numbers at the bottom of the table it will be seen that the average duration of a fixation pause for all of the pictures and for the entire group of subjects was 10.1 thirtieths of a second. However, the average duration of the first fixations for the entire group of subjects was but 6.3 thirtieths of a second. The average duration for the first five fixations for each subject was then computed and was found to be 8.2 thirtieths of a second. The same type of average for the second five fixations was found to be 9.7 thirtieths of a second. Without continuing the analysis by groups of five throughout the entire picture, the next column gives the average duration of the last five fixations for each subject. This average was found to be 11.0 thirtieths of a second. Consequently, the data are found to verify the hypothesis that successive fixations tend to increase in duration, the averages for the successive groups being 6.3, 8.2, 9.7, and 11.0 thirtieths of a second.

The last two columns in Table V show something of the range of variation for duration of fixations. The next to the last column gives the average duration for the shortest fixation of each subject in the group, whereas the last column gives the same kind of average for the longest fixations. The average duration of the shortest fixations is 3.1 and for the longest fixations is 38.5 thirtieths of a second.

A still different method of studying variation in duration of fixations is to make an analysis of durations in the records which are exceptionally long. Consequently, all of the records in the complete file of materials for the investigation in which there were 100 or more fixations were selected for study. There were 153 such records. The results of this analysis are presented in Table VI which shows the average duration of fixations for successive groups of 25 fixations. For example, if a given record had 150 fixations, the average was computed for Fixations 1–25, then for Fixations 25–50, etc. In this manner any tendency for fixations to increase in duration during the process of looking at a picture for a long time would become apparent. There were eight cases in the files for which the record of eye movements in looking at a single picture included 200 or more fixations. The first row of figures in Table VI gives the data for these subjects, showing that for the first 25 fixations the average was 8.3 thirtieths of a second, and for successive groups of 25 the averages were 8.8, 9.5, 9.1, etc. It will be seen that there is a gradual tendency to increase up to the group of fixations numbered 76 to 100; that following that point there was no increase and but little variation in either direction until the last group of 25 fixations, where the average was 9.7 thirtieths of a second. In interpreting the data from Table VI the reader should keep in mind that the average for the first 25 fixations covers up the increase from Fixation 1 to the average for the first five and then to the average for the second five, which was shown in Table V to be a very considerable increase.

There were 22 cases, as shown in Table VI, for whom the film records contained 175, but less than 200, fixations. With minor variations there is a general tendency for the fixations to increase in length, the range being from 8.1 for the first 25 fixations to 9.3 for the last 25 fixations. Forty subjects were available whose records included 150, but less than 175, fixations. Here there is a steady increase up to the group of fixations numbered 101 to 125, but a slight falling-off in the next group of fixations. The last row of numbers in the table, which includes the entire group of 153 subjects for the first 100 fixations, shows a steady increase up to the last group of 25 fixations where there was a drop from 9.1 to 8.8 in average duration. One may generalize, therefore, by saying that in groups of 25 there is a gradual increase in the duration of fixations up to the end of the 75th fixation and with some variations increases are apparent up to the 200th fixation. The longest average duration of fixations which appears in the entire table is 9.7, which is for the group of 8 subjects in those fixations numbered from 176 to 200.
It would be interesting to supplement this study by a further investigation of the duration of fixation pauses of persons especially interested in art who would study the pictures for long periods of time, even as much as 1,000 or 2,000 consecutive fixations. Needless to say, the plotting of even one such record, which would involve in the neighborhood of 10,000 dots on the film to be counted and located, would be an exceedingly time-consuming project. Furthermore, both subjects and pictures would need to be so selected that the investigator could be sure of sustained attention for that long a period of time.

One further method of studying fixations of long duration will be presented. In Plate XLVII there is shown for Picture 13 the distribution of the fixations of 20 or more thirtieths of a second in duration for a group of 38 subjects. The first 30 fixations for each of this group of 38 subjects are included, making a total of 1,140 fixations in all. Seventy of these 1,140 fixations were 20 or more thirtieths of a second in duration. This is 6.1 per cent of the total number and is quite typical of the percentage of fixations of this duration which are found in any picture, the average in most cases ranging around 5 or 6 per cent. The limit of 20 thirtieths of a second is taken in a purely arbitrary manner. As will be seen in Plate XLVII, 16 of these long fixations occur in Rectangle 6 and also 16 in Rectangle 11. These are the two rectangles which received the largest percentage of all fixations, and they may be thought of as chief centers of interest for this picture. Rectangles 12 and 15 each received 5 long fixations. Rectangles 1, 2, 5, and 10 each received 4 long fixations. Two of the rectangles, Numbers 4 and 14, received no fixations of 20 or more thirtieths of a second in duration. In the case of Rectangle 4 this is not surprising in view of the fact that nothing appears there except sky and it received a very small number of fixations of any duration. Rectangle 14 contains a considerable amount of detail but no item of special interest.

Analyses similar to that shown in Plate XLVII were made of several other pictures with substantially the same results. In Picture 12, “The Solemn Pledge,” the great majority of the long fixations fell on the faces of the Indians. In Picture 11, “The Judgment of Paris,” 22 of the 57 long fixations fell directly on the four heads of the individuals in the picture, whereas 13 additional fixations fell within a few millimeters of the heads. Here again it is clear that the main centers of interest, as judged by number of fixations, also receive the fixations which are longest in duration.
While the duration of fixations will need to be made the subject of further study, certain generalizations seem to be justified. In the first place, the evidence is clear that the earliest fixations are the shortest ones and that there is a gradual tendency for the duration of fixations to increase, both in the early part of the picture and throughout successive groups of 25 fixations for the entire period of looking at the picture in the case of most subjects. In the second place, it is evident that the duration of fixations is a factor influenced very much more by the individual characteristics of the observer than by the nature of the picture being observed. This suggests that interesting hypotheses for further study might relate to the familiarity of the subject with the picture, to the type of motivation in looking at it, to his general interest and experience in the field of art, and to certain other purely individual factors. In the third place, it appears that the fixations of exceptionally long duration fall, for the most part, on those portions of the picture which, judged by the number of fixations, seem to be the principal centers of interest.

CHAPTER IV
VARIATIONS IN PERCEPTION RELATED TO CHARACTERISTICS OF THE PICTURE

The material in this chapter will be presented in five sections and will deal respectively with the following topics: first, the effect of color in a picture; second, the effect of a miscellaneous group of special factors upon perception; third, perceptual patterns in looking at designs of various types in some of which the effect of balance can be observed; fourth, the effect of silhouettes and outlines upon perception; and fifth, differences in looking at a finished and an unfinished painting.

THE EFFECT OF COLOR

Several colored pictures were used in this investigation. However, the specific comparison of the effect of color or lack of color will be based upon the use of Pictures 1 and 2, “Mount Equinox—Winter,” in which the only difference was the factor of color. Picture 1 was in black and white; Picture 2 in color. Several types of comparison will be made using these two pictures.

In order to make a comparison of the amounts of attention given to the different parts of the picture a study was made of 42 subjects each of whom had looked at both pictures. In half of the cases Picture 1 was seen first; in the other half of the cases Picture 2, the colored picture, was seen first. To make the comparisons valid an equal number of fixations from each subject for the two pictures was used. For example, if one subject had made 67 fixations in looking at the uncolored picture and 82 fixations in looking at the colored picture, only the first 67 in the latter case would have been used.

The results of the foregoing method of comparison are presented in Plate XLVIII which shows the percentages of the total number of fixations falling in each of the 16 rectangles into which the pictures were divided. The upper number in each rectangle shows the percentage of fixations for the uncolored picture, whereas the lower number shows the percentage of fixations for the colored picture. The most striking character-
istic of the plate is the high degree of similarity in the distribution of attention for the two pictures. In the four rectangles across the top of the picture the difference in each case is 0.2 per cent. However, in two cases the greater percentage occurs on the colored picture and in two cases on the uncolored picture. In view of the fact that the upper tier of rectangles contains only sky and that in the colored picture this is of almost uniformly blue color the similarity may not be surprising. In the second tier of rectangles some of the brightest colors in the picture occur. Rectangle 6, in particular, contains a considerable portion of the bright side of the mountain. Here the number of fixations for the colored picture was 2 per cent greater than for the uncolored picture. Rectangle 12 also contains a large part of the vivid coloring at the right central part of the picture. Here again the colored picture received 10.8 per cent of the fixations, whereas the uncolored picture received 9.1 per cent. On the whole, the contrast between the two pictures in the distribution of fixations in the various rectangles is not striking.

A somewhat different method of comparison may be made by outlining the two major spots of bright color and then tabulating the number of fixations which occurred in those two areas. Accordingly, an outline was sketched around the bright orange coloring in the mountain, which will be designated as the area to the left, and around the bright orange color in the right central part of the picture, which will be designated as the area to the right. A third outline was sketched in oval shape to include the large deer running across the center of the picture. In the colored picture, this deer is a light brown or fawn color. The number of fixations was then tabulated for these three areas for two pictures, showing the total number falling in each area for the first three fixations, and then for successive groups of three fixations up to and including Fixation 18. The results of this tabulation are shown in Table VII. From the totals at the bottom of the table it will be seen that the left area received 145 fixations in black and white and 125 fixations in color, that the right area received 39 fixations in black and white, but 66 fixations in color, whereas the deer received 120 fixations in black and white and 155 fixations in color. As far as the left area is concerned, the colored picture attracted fewer fixations than did the uncolored one. For the area at the right, the bright color

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1 The picture is not reproduced in color in the Appendix, but since it is so well known the reader will doubtless recognize the colored areas described in this paragraph.
attracted and held a considerably larger number of fixations than did the uncolored picture. Likewise, in the case of the deer, the color resulted in an increase of 35 fixations on that area.

The comparison of the three areas is somewhat more significant if the two pictures are studied in successive groups of three fixations, rather than simply by totals of all fixations. For example, the area at the left, for the picture in black and white, received 26 fixations in the first three, 42 in the second three, and then showed a somewhat irregular decrease for the next four groups, ending with a total of 18 for Fixations 16–18. In the case of the colored picture this area attracted less attention during the first six fixations, but beginning with Fixations 7–9 a total of 32 fixations occurred in this area. For the right area, it is interesting to note that in both the uncolored and the colored pictures attention, as measured by the number of fixations, showed a rather consistent increase for successive groups of three fixations. For the picture in black and white each successive group of three fixations showed a larger number in this area. For the picture in color the attention on this area builds up more rapidly but drops off somewhat in the last group of fixations.

A third method of comparing the effect of color is in regard to the effect on duration of fixations. Accordingly, a comparison was made of average duration, based upon all fixations. The total number of fixations involved was 2,407 for Picture 1, and 2,486 for Picture 2. The average duration of fixations for Picture 1, for all subjects, was 9.8 thirtieths of a second. For Picture 2 it was 9.3 thirtieths of a second. The difference is too small to be interpreted as having any great significance.

As far as the data from Pictures 1 and 2 are concerned, color or lack of color has no striking effect upon the general character of the perceptual process. The data presented here are admittedly limited and the problem should be studied further. However, as far as the data in the present study are concerned one might infer that whatever differences color in a picture may produce, these differences are little evident in the perceptual pattern. It may be that the chief effect of color is in a pleasing mental experience and that the satisfyingness or lack of satisfyingness of experiencing color is not revealed in the characteristics of eye movements.

One general limitation of the data relating to color may be due to the fact that the colored pictures selected do not appear to any great disadvantage when printed in black and white. This is especially true of Pictures 1 and 2. If color had been used in some unexpected way and if the main emphasis in the pictures had been on color rather than on form, the results might have been different. Any further study of the effect of color should take these facts into account.

### Table VII

<table>
<thead>
<tr>
<th>Groups of Fixations</th>
<th>Sections of Picture 1 (Not Colored)</th>
<th>Sections of Picture 2 (Colored)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left</td>
<td>Right</td>
</tr>
<tr>
<td>1–3</td>
<td>26</td>
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<tr>
<td>4–6</td>
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<td>7–9</td>
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<td>10–12</td>
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<td>9</td>
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<td>13–15</td>
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<td>16–18</td>
<td>18</td>
<td>13</td>
</tr>
<tr>
<td>Totals</td>
<td>145</td>
<td>39</td>
</tr>
</tbody>
</table>
tion of the waves attracted the greatest amount of attention and the sky received very little notice. Horizontal movements were more characteristic than vertical movements.

Picture 33, archaeological pieces, showed results quite in accord with those for Pictures 31 and 32, with the exception that the inscriptions above and below the main figures attracted considerable attention from some subjects but very little from others.

Picture 44, a picture of the Rosenwald Museum and the landscape surrounding it, was selected chiefly because of the horizontal lines in the architecture of the building. However, the drives running through the landscape are quite conspicuous and the cloud effects are particularly interesting. The majority of subjects gave very little attention to the clouds. The eye movements showed marked horizontal excursions and for a number of subjects a rather detailed examination of the landscape. This latter characteristic of perception may have been due to the fact that the grounds are adjacent to the University of Chicago and that many of the subjects were so familiar with the environment that they evidently tried to recognize certain details in the landscape.

Picture 40, shown in Plate XLIX, shows some very interesting characteristics of perception in looking at the details of architecture. The very striking cloud effect in this picture was ignored by practically all the subjects although in one or two cases there was a very detailed examination of the clouds. In general, the pattern of perception for Picture 40 started with the lower part of the picture, swung up the column to the upper part, where great interest was evidenced in the details of decoration, and then back again to the columns in the part of the building at the lower left. Plate XLIX shows quite typical performance, as indicated by the greater portion of the group of subjects for whom records were made for this picture.

Two other architectural views are shown in Plates L and LI, which present pictures of two churches with marked contrast in their styles of architecture. For Picture 42, as shown in Plate L, the effect of the tall spire is very pronounced and the pattern of perception exhibited in this particular plate was quite characteristic of that of the majority of subjects. The pattern of perception displayed in Plate LI, the picture of the Copenhagen church, shows rather clearly the effect of this type of architecture. For the majority of subjects the chief center of interest in the beginning
was the area above the doors and around the circular window. The tower attracted a great deal of attention and a considerable amount of detailed examination was given to the decoration at the top and to the cross just below this decoration. The picture brought out marked vertical movements up and down the tower and also pronounced horizontal movements across the lower part of the picture.

Picture 35, which is quite different in subject matter, was introduced to indicate the manner in which certain characteristics of line influence perception. As shown in Plate LII, the eye follows very closely the details of the picture.

THE EFFECTS OF VARIOUS TYPES OF DESIGN AND BALANCE

In design, perhaps more than in any other type of art, one might expect the pattern of perception to be influenced by the character of the lines. In this section the behavior of the eyes will be shown for several types of design.

Some discussion has already been given to the effect of decorations on china or brass such as appears in Pictures 21 and 22. Additional study of this type of decoration was made for Pictures 18, 19, and 20. In general, the patterns of perception for these three pictures were similar to those already described in the case of Pictures 21 and 22.

A somewhat more interesting design is that shown in Picture 26, one plotting of which appears in Plate LIII. In terms of some of the a priori discussions in books on art one would expect to find the eye following in some detail the circular patterns in this design. The four major spirals in the picture are thought by some writers to lead the eye around and around toward the center of the spiral. Furthermore, the main trunk leading up through the center of the picture and then spreading to the spirals might be thought of as a determiner of perceptual pattern. As a matter of fact, no records were found in which there was anything approaching an attempt to follow the lines of the spirals around and around toward the center. The record shown in Plate LIII, which is an example of a more specific reaction to the details of the pattern than was found in the case of many records, indicates no attempt at any place to follow lines consistently. In this plate the subject first looked at approximately the center of the picture. He then moved to the left, made a series of four fixations on the burr in that position, and then proceeded to make a somewhat general survey...
of the main centers of interest—first, the large spiral at the left, then the one at the upper right, the burrs at the top center, and then the spiral at the lower right. Finally, this subject moved back across the center of the design. When the fixations for a group of 25 subjects looking at this design were tabulated according to position in the 16 rectangles, it was found that the results accorded fairly closely to the expectation for such a balanced design. There were somewhat more fixations on the right half of the design than on the left. The column of rectangles at the extreme left included 8 per cent of the fixations, whereas the column at the extreme right included 11.5 per cent. For the left center column the total percentage of fixations was 36.4, whereas for the right center column the percentage was 43.8. Fifty-seven and nine-tenths per cent of all the fixations fell in the four center rectangles.

Picture 25, showing the stairway, furnishes another marked illustration of how eye movements follow the general pattern of a design. Here again there is no evidence of a series of rhythmical movements going either up or down the stairs in units corresponding to those shown in the decoration of the design, but there is a marked tendency to follow the general pattern both up and down. The illustration given in Plate LIV is quite typical of the behavior of the eyes for this picture.

A somewhat different situation than that found in the two pictures just described is evidenced in Plate LV, in which there are samples of three colored prints in which the main lines of the design run vertically. The picture was in color and the subjects were asked to look at the three designs and state which one they liked best. The situation involved an element of comparison. It should be noted, also, that the three designs are not equally wide, the one on the right being considerably narrower than the other two. The reaction shown in Plate LV is quite typical. Few subjects covered the whole design with their eyes, but tended to look at the central portion of the various panels or to let the eyes follow up and down the main direction of the design. In the plate shown, the movements in the vertical direction are much more marked in the sample at the right than in the other two samples. The sample in the center received much less attention than the other two. The movements of the eyes back and forth from sample to sample can be traced from the horizontal lines going from one panel to the other.

A situation somewhat similar to that for Picture 37 was found in Picture
38, which showed a group of four sample prints which the subject was again asked to compare and then to select the one preferred. In this picture, also, the subjects tended to limit themselves quite generally to an examination of the central portion of each panel. Individual preferences were quite clearly marked and the four samples received by no means an equal amount of attention.

Picture 39 was used in order to see the effects of a pattern of design which was, with the exception of the border, the same all over. In the part of the picture which was alike all over the eyes made a general survey covering the greater part of this section. For some of the subjects the border design produced a series of consecutive fixations not regular in spacing, but following in the main the left and lower sides of the picture. The signature and date in the lower left corner attracted the attention of some of the subjects, but was overlooked completely by a considerable number of them.

Two pictures, Pictures 24 and 23, were used to study the influence of lines and decoration in furniture. Picture 24, which was shown in color, has a considerable number of lines and edges at right angles as well as a number of decorative panels. In the main the eyes followed the lines of the figure with occasional interruptions for examining details of the decoration. Picture 23 furnished an excellent example of the way the eye follows the main lines in a piece of furniture of this type. Record after record showed a clear tendency to follow the lines of the couch back and forth laterally, and then to make movements down to the feet at each end. In some cases the shape of the couch could almost be traced from the lines connecting the successive fixations of the eyes.

Another class of design which is of unusual interest from the standpoint of eye movements consists in those repetitive patterns which are used for borders. Two assumptions appear rather commonly in the literature of art relating to the characteristics of perception in looking at such border designs. In the first place, it is assumed that the rapidity of eye movements in either direction is determined by the characteristics of the design. Some designs which consist of vertical cross-sections of the border, or of circles or dots, are spoken of as static designs, not leading the eye in one direction or the other, whereas in other cases where the main lines of the design assume an oblique direction and where certain curves and angles are introduced the assumption is that the eye is carried forward more rapidly along the border. A second assumption which appears occasionally in the literature is that the satisfaction experienced in looking at a border design is due to the fact that the repetitive elements which constitute the rhythm of the design produce a corresponding muscular rhythm in the movements of the eyes, and that it is the sensation from these rhythmical movements of the eyes which produces the particularly pleasing effect of certain types of border design.

In order to study these various hypotheses six sample border designs were used. These are displayed in the three parts of Plates LVI and LVII. In Plate LVIa the design may be described as static. In LVIb the movement is assumed to be somewhat greater, whereas in LVIc the border is designed to produce even more rapid movement from left to right. In the three sections of Plate LVII the borders consist of variations of the same figure of a dog. Plates LVIIa and LVIIb are alike except for the fact that in one case the dogs are all moving from right to left, whereas in the other case they are moving from left to right. In Plate LVIIc two variations are introduced. While the general movement is from left to right and is similar to Plate LVIIb, the fourth dog from the left is made to reverse his direction, and the third dog from the right not only reverses his direction but also changes his position somewhat. The general wave effect at the base of the design is modified somewhat on account of the change in direction of these two dogs. Records for these six designs were taken for twenty-one subjects. The order of presentation was varied for the different subjects in order to compensate for the influence of familiarity. Plates LVI and LVII show individual records in looking at the six patterns.

In the case of Plate LVIa the subject began by fixating near the center of the design. There then followed five fixations to the left which extended to almost the extreme left end of the border. The eye then moved to the right until Fixation 8 was reached, following which there appears a series of backward and forward movements. Finally the eye made an excursion to the extreme right end of the border and then swung back again to the left. In the plates which are shown the records are cut off arbitrarily at the end of the twenty-fifth fixation. However, following this point the main pattern is quite similar to that shown in the first twenty-five fixations. Plates LVIb and LVIc do not show any very marked differences as compared with Plate LVIa. Certainly from an inspection of the eye movements without knowing which set of fixations belonged to which design one would not be able to tell which were for the static and which for the moving designs.
Record of Eye Movements for Picture 30
Upper Design, a—Subject 103; Center Design, b—Subject 103; Lower Design, c—Subject 98
Plates LVIIa and LVIIb show the record for Subject 103 in looking at the border of dogs where in the first case they are moving from right to left and in the second from left to right. In Plate LVIIa the subject's first fixation was at the right end of the design and moved from there over to a left position, after which there was a series of movements to the right end of the line and then back again to the left. In this record there is no conspicuous difference in the characteristics of the eye movements toward the left and the right. In Plate LVIIb the eyes moved more quickly, that is, with fewer fixations, from the left to the right end, whereas from the right to the left they moved with a series of shorter fixations and with occasional regressive or backward movements. In Plate LVIIc the eye started nearer the right end of the line, moved well to the left, and then oscillated back and forth over the positions of the third and fourth dogs. It should be noted that the fourth dog from the left is the one whose direction of movement is irregular. In the latter part of the record, from Fixations 19 to 24, there is again an oscillation back and forth with a cluster of fixations over the third dog from the right, which again is the dog moving in the irregular direction. In none of these three pictures could the eye movements be described as rhythmical in character. There is no evidence whatever that the eye jumps from dog to dog. There are ten dogs in each series and if the movements were rhythmical one might expect a series of ten successive fixations moving from figure to figure.

In the plottings presented in Plates LVII the data are limited to the records of single individuals. In order to determine the general nature of a pattern of perception in looking at designs such as these, the records for a group of individuals were combined and the results are shown in Figures 2 and 3. The center line of each of these figures represents the position of the median fixation for the group of subjects for the first 20 fixations of the eye for Figure 2 and the first 22 fixations in the case of Figure 3. The dots in the line at the left show the successive positions of the lower quartile in the distribution, whereas the dots in the line at the right show the same for the upper quartile. The quartiles are shown in order to indicate the degree of consistency for the middle half of the group. In Figure 2 the general patterns for the median and for the quartiles are very similar. For each of the pictures the general tendency is to start near the middle of the border, to move first to the left in a series of fixations, and then to the right, following which the eye tends to zigzag back and forth.
forth more or less in the center of the pattern. A particular characteristic to which the attention is called here is the very general tendency for the eye to move first to the left and then to the right. Whether or not this is a carry-over from the ordinary process of reading cannot be known from the data available. However, there is a considerable body of evidence to lend strength to this hypothesis. In Figure 3, the same general pattern of perception is apparent, namely, that the initial fixations tend to start near the center of the border, to move first to the left in a series of fixations, and then a considerable distance to the right, following which they tend to zigzag back and forth. The reader should remember that in Figure 3a, the general direction of movement of the dogs is from right to left, whereas in Figure 3b, the general direction of movement is from left to right. The median curves for Figures 3a and 3b indicate that the eye swung approximately the same distance to the left when the dogs were going in that direction as when the dogs were going in the opposite direction. However, the swing of the median line to the right is somewhat greater in Figure 3b, where the dogs are moving from left to right than in Figure 3a where the dogs are moving in the opposite direction. Figure 3c shows rather clearly the influence of the two dogs that interrupt the general series of movement. The first general swing of the median line from the center toward the left extended only slightly beyond the position of the irregular dog, but in the following swing from left to right it extended far enough to cover the position of the irregular dog at that end of the border.

The data presented in Figures 2 and 3 deserve rather careful analysis. The effect of different types of design in carrying the eye swiftly from one place to another is apparently much less than is assumed in the literature of art. The feelings of swift movement, if such are actually present, are not accompanied by corresponding movements of the eyes. It is evident that the movements of the eyes are adjusted in some manner to produce the most effective pattern of perception, but the inner interpretation from these patterns of perception are in all probability derived from ideational and emotional experiences which are quite unrelated to the particular movements of the eyes at a given time. The writer should emphasize again that the data from eye movements are not to be considered as evidence either positively or negatively for any particular type of artistic interpretation. It is quite to be expected that the mind readjusts the data which it receives through patterns of perception in accordance with the
general ideational and emotional demands of experience, in much the same way that the mind rearranges the perceptions of words presented through various patterns of eye movements in reading a Latin passage, in which case, for a mature reader, the eye takes in the successive phrases as they come, regardless of grammatical construction. The necessary re-arrangement of logical interpretation is made through the central thought processes. The general patterns of perception for a mature reader are the same for reading Latin and reading English in spite of the fact that the general grammatical construction for the two languages is quite different. There is no apparent reason why a feeling of rapid progression along a border design or a feeling of the rhythm which the design presents should necessarily be accompanied by a set of eye movements which resemble in serial order or in rapidity of progression the particular characteristics of the design being observed.

One other interesting aspect of the perception of border designs is the duration of fixation pauses. The three designs shown in Picture 29 were so selected that Design a is presumably more static than the other two, and that Design c would induce more rapid movements of the eyes than Design a. Rapidity of movement may be thought of in terms of long swings from position to position or in terms of duration of fixations, the more rapid perception of a design being the one in which the duration of fixations is shorter. In view of the fact that the time required for an eye movement, which approximates a thirtieth of a second, is so small in comparison with the total amount of time given to the fixation pauses, any notable difference in speed of perception must result from a difference in the duration of the pauses of the eye rather than in variations in the time of the actual movements of the eyes. A computation was made of the average duration of fixations for a comparable group of subjects, where the same individuals looked at each of the border designs and where the same number of fixations for each individual, namely, twenty, were studied. It was found that the average duration for Design a was 8.1 thirtieths of a second, while for Designs b and c the average durations were, respectively, 8.4 and 9.2 thirtieths of a second. These averages are rather disturbing in the face of the assumptions which have been commonly made in regard to the speed of movement in perceiving these three kinds of patterns. According to the assumption one would expect that the static design would result in longer fixations and that the designs which presum-ably impel more rapid movement would result in shorter fixations. Exactly the opposite occurred. It is altogether more probable that the reason for the difference in duration is the fact that the first design is less interesting than the others, due to the fact that its lines and structure are more simple and, therefore, easier to perceive. Designs b and c are somewhat more complicated, which may account for the longer duration.

Some additional information on the comparisons made in the foregoing paragraph may also be obtained from Picture 30a, b, and c in which the units of the design are exactly the same, the identical motif being used in each successive unit. The average durations of fixations for these designs were somewhat longer than for the three designs in Picture 29. The average for Design a was 10.0 thirtieths of a second, for Design b 11.2, and for Design c 9.1 thirtieths of a second. Here again the data seem somewhat contradictory to the common assumption in regard to speed of movement. The ordinary movements of the eyes in reading are from left to right and, from evidence outside the field of art, it would be expected that the movements of the eyes in that direction would carry on with somewhat greater facility than in the reverse direction. In Design a the progression of the figures is from right to left, the opposite direction from that which occurs in reading. Nevertheless, in this picture the average duration is 10.0, whereas in Design b, where the direction is the same as that in reading, the average duration is 11.2. For Design c the average drops to 9.1. In this case the interruption caused by the two dogs moving in an irregular manner has resulted in a shorter average duration of fixation pauses. This is quite in accord with the hypothesis proposed earlier in regard to duration of fixations, namely, that when the difficulty involved is primarily perceptual in character the fixations may be expected to be shorter than when the difficulty or interest is primarily one involving reflection. The general results from the entire body of data relating to the border designs indicate that some rethinking of the psychology of perception in these relationships is necessary.

One of the items to which the writer had planned to give attention in this report was the effect upon perception of various types of balance in a picture. The problem is quite complex and the variations in the data obtained render it desirable to reserve any extended treatment of this problem to a later time. In fact, an entire investigation of the scope of the present one could profitably be made on this single topic. The records of eye
movements which have been shown previously in this report will in many cases show how various factors of balance in a picture have affected single individuals. Certain pictures were selected in which the lateral balance was so nearly even that some special study was made of them. Plates LVIII and LX, showing Pictures 27 and 28, show the reactions of two subjects to a picture which is quite symmetrical laterally. The symmetry is not perfect due to the variation in lights and shadows. However, it is clear from these two records that, at least as far as these individuals are concerned, the degree to which the fixations on each half of the picture will balance depends upon the duration of the total exposure of the picture. An enormous amount of individual variation in this particular factor was apparent, some subjects oscillating back and forth frequently from one half of the picture to the other, whereas other subjects would spend a considerable amount of time examining in detail one half and would then turn to the other half for a detailed examination. No generalizations are presented on this general subject of balance as illustrated in these two plates, and the plates will simply be considered as examples of the type of data which an extended study might secure for this problem.

The problem of balance can be reduced to a somewhat more simple form by the use of geometrical figures. Plate LX shows four figures which were especially constructed for this particular type of study. In Plate LX a the two halves of the drawing are exactly symmetrical, both in shape and size. In Plate LX b the two halves are symmetrical in general shape, but one is reduced to half the width of the other. In Plates LX c and LX d the two halves are asymmetrical. In one case the total volume of area in the two halves is the same, whereas in the other case the volume in one side, the left, is half that of the right side. Here again the plate merely shows the record of four individual cases. The variations from individual to individual in the group of pictures taken were so large that no attempt at generalization can be made until a much more extended series of pictures can be secured than was possible in the present study.

LOOKING AT SILHOUETTES AND OUTLINES

Plate LXI shows the eye-movement record for one individual in looking at Picture 51. In this picture the same church appears in three forms: first, in outline form; second, in solid black with the windows and decora-
tions outlined in white; and third, simply as a silhouette in solid black. The record which is presented in Plate LXI is typical of the entire group in several respects. The central picture attracted more attention for all of the subjects. On the whole, the solid black silhouette at the right attracted more attention than the outline of the church as shown on the left. The actual number of fixations on each third of the picture for the group of 29 subjects was 293 fixations on the church at the left, 973 fixations on the center one, and 353 fixations on the one on the right. The extent to which the central picture received more attention because of the decoration appearing on it, and the extent to which this was due to the fact that it was located in the center rather than on one of the two sides, cannot be determined from the data at hand. There was considerable variation among the subjects in regard to the parts of the churches which attracted most attention. For some subjects practically all of the attention went to the three spires, whereas other subjects gave little or no attention at all to the spires and concentrated their fixations on the main body of the church below. For the solid figure at the right there was a tendency for the fixations to fall within the main portion of the church below the spire, whereas in the outline figure there was more of a tendency for the fixations to fall near the edge of the outline rather than in the plain white space in the center. There were no cases where the eye movements followed around the outline of the church with any precision.

FINISHED AND PARTLY FINISHED PICTURES

Two pictures of a water-color painting were used which, in the first case, consisted in the partly finished painting and, in the second case, of the completed picture. These two pictures are shown as Pictures 15 and 16. The record of one subject is shown in Plates LXII and LXIII. The increased amount of detail in the center and lower part of the finished picture attracts considerably more attention than in the unfinished picture. Likewise, less attention is given to the hills and the background at the left when the picture is finished and when there are more competing details in the lower part of it. When the distribution of the fixations into the sixteen rectangles was made for a group of 19 subjects it was found that the principal increases for Picture 16 occurred in those rectangles which included
the lower part of the wall and the sailboat. In these rectangles, which were Rectangles 6, 7, and 10, the number of fixations for Picture 16 increased by 11.2 per cent. The upper four rectangles, which included mainly sky, received 2.1 per cent more fixations in the unfinished picture than in the finished picture. In general it may be said that the addition of details in the finished picture attracted the fixations of the eyes to the parts of the picture where previously there was little detail to attract the eye. As a result, in Picture 16 there was less attention to the sky, less attention to the water in the lower right portion, and less attention to the lower left corner; whereas the increases in attention were on those portions of the picture which had been enriched in detail in the finished product.

CHAPTER V

VARIATIONS IN PERCEPTION RELATED TO CHARACTERISTICS OF INDIVIDUALS

One of the questions which was studied in this investigation is what relationship certain characteristics of individuals may have to the nature of perception in looking at pictures. In this chapter three aspects of this question will be considered. First, do persons with training or special ability in art show characteristic differences in looking at pictures as compared with persons without training or special ability? In the second place, do children and adults display the same general characteristics of perception? It has been shown that, in learning to read, the characteristics of eye movements undergo a series of well-marked changes during that period of years in which the reading process is maturing. Is there a similar process of maturing or learning to look at pictures during which children display patterns of perception which vary from stage to stage as they grow older? The third question is whether differences of nationality or race may affect the character of one’s perceptual habits. For example, in looking at a Japanese print would Oriental subjects display the same characteristics of eye movements as subjects living in America? In the present chapter some evidence relating to these three questions will be presented.

THE RELATION OF TRAINING AND SPECIAL ABILITY IN ART TO THE PERCEPTUAL PROCESS IN LOOKING AT PICTURES

As has already been stated in the introductory chapter, forty-seven of the subjects used in this investigation were students in the Art School of the Art Institute of Chicago. The great majority of these students had more than two years' training, in many cases the period of special study of art amounting to four or five years. In addition to these students from the Art Institute certain other subjects were used who had had special training in art in other institutions. All told there were sixty-one subjects which are classified in this investigation as belonging to the art group. All other subjects, with the exception of elementary-school children, were classified
in the non-art group. The elementary-school children were not considered in either of these two groups.

It is quite conceivable that study in a school of art is no guaranty that a student possesses artistic talent or that he profits greatly by such training, since in many art schools anyone can be admitted if he pays the tuition. It is quite to be expected that some persons, by this method of classification, might be counted as art students who would not possess the characteristics of this group in general.

As a supplementary method of classification all of the subjects in the experiment, with the exception of the elementary-school children, were given the McAdory Art Test. The McAdory Art Test consists of a series of seventy-two plates on each of which are four pictures consisting of a great variety of materials, designs of one sort or another, pottery, pictures in color as well as black and white, etc. In view of the length of time required for taking the entire test the plates were divided into two groups on the basis of an experimental try-out in such a way that the two halves of the test gave substantially the same score. For purposes of this investigation, a form consisting of half of the items of the test was used. Furthermore, the method for scoring the test which was available in 1932, the time when this investigation was begun, was modified in favor of an improved method of scoring. This method of scoring is described in detail in Appendix B.

As shown in Table VIII, the group of art students made on the average the middle 50 per cent, whatever characteristics are found for the remaining two groups will be less affected by overlapping abilities and will give a clearer picture of whatever differences exist between the two groups.

### Table VIII

<table>
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<th>Group</th>
<th>Number of Cases</th>
<th>Median</th>
<th>Upper Quartile</th>
<th>Lower Quartile</th>
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<tr>
<td>All adults</td>
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<td>176.3</td>
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<td>High school</td>
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<td>173.0</td>
<td>180.5</td>
<td>167.0</td>
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<td>All art students</td>
<td>59</td>
<td>177.3</td>
<td>183.3</td>
<td>169.4</td>
<td>124-99</td>
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<tr>
<td>Non-art adults</td>
<td>88</td>
<td>176.5</td>
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<td>168.3</td>
<td>125-96</td>
</tr>
<tr>
<td>Selected art group</td>
<td>30</td>
<td>177.0</td>
<td>182.5</td>
<td>167.5</td>
<td>124-99</td>
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*The scores of three adults are omitted from these computations since these subjects were added after this part of the study was completed. The three scores were 170, 190, and 194.*

### Table IX

<table>
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<th>Picture Number</th>
<th>Total Number of Cases</th>
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<tr>
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<td></td>
<td>8.9</td>
<td>8.6</td>
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If there are any consistent differences due to special ability, as shown by the scores on the art test, or due to training, as evidenced by several years study in an art school, one would expect them to be displayed in duration of fixation pauses. This possibility was tested by such comparisons as are shown in Table IX, which is based on seven of the pictures used in this investigation.

As shown in Table IX, the group of art students made on the average
8.9 thirtieths of a second per fixation pause, while the duration for the non-art group was 9.8 thirtieths. Furthermore, this difference was consistently true for each of the seven pictures as well as the average, the duration of fixations for the non-art group being longer in every case. Likewise, when the group of 30 specially selected art students was studied in the same manner, the tendency for students of art to make shorter fixations than the non-art group is quite consistent. It was found that the average duration of their fixations was 8.6.

When the higher quartile and the lower quartile groups on the art test are compared, no consistent differences are found. For four of the pictures those in the high quartile made longer fixations than those in the low quartile. For the other three pictures the reverse was true. As far as this investigation is able to determine, duration of fixation pauses during the first twenty-five fixations shows no significant difference between the two groups classified by score on the art test.

In view of the fact which has been shown earlier that the duration of fixations increases during the latter part of a long observation of a picture, a special comparison was made of Fixations 76–100 for a group of 26 subjects who ranked in the lower quartile on the test and 33 subjects who ranked in the upper quartile. Using all the pictures for these subjects where there were as many as 100 fixations, the average duration time for Fixations 76–100 was 9.3 thirtieths of a second for the upper quartile and 9.7 for the lower. For this same group of subjects looking at the same pictures the corresponding averages for the first 25 fixations were 8.5 and 8.4 thirtieths of a second. In both groups the average duration of a fixation increased during the latter part of the film, but the differences in average duration between the two groups for the same series of fixations was very small. The specially selected group of 30 art students made an average duration of 8.8 thirtieths of a second for Fixations 76–100, which is shorter than the averages for both upper and lower quartile groups.

In respect to duration of fixations, the group which had studied art made consistently shorter durations, both during the first 25 fixations in looking at seven different pictures and during Fixations 76–100. On the other hand, ability as measured by the art test apparently has little relation to duration of fixation pauses. Attention will now be given to the possible effects upon position of fixations and centers of interest.

Comparisons were made both by general distribution of fixations in group density plots and by tabulations of the percentage of fixations in each of the sixteen rectangles of various pictures. The results here, as in the case of duration of fixation, were not conclusive. Minor differences were apparent from picture to picture, but no consistent major differentiation in the patterns of perception could be identified. The average differences between the groups were so much less than the individual differences within each group that the results cannot be considered significant.

The following comparisons may be cited as random samples of the differences which were found. In looking at Picture 47, a cathedral interior, those subjects in the upper quartile on the art test gave much more attention to the lower half of the picture, whereas subjects in the lower quartile gave more attention to the upper half of the picture. However, the paired groups of subjects available for this particular comparison was small, there being but sixteen cases in each quartile. For these two groups of sixteen cases the upper group had 55.3 per cent of its fixations in the lower half of the picture, whereas the lower quartile had 55.8 per cent of its fixations in the upper half.

For Picture 9, “Stowing the Sail,” the subjects in the upper quartile on the art test placed 49.6 per cent of their fixations in the center four rectangles, whereas those in the lower quartile placed 57.2 per cent of their fixations in the same area.

For Picture 2, “Mount Equinox, Winter,” in color, the subjects were divided into thirds. Of those in the upper third according to the art test, 2.3 per cent of the fixations were on the top row of rectangles, that is, the row including the blue sky, whereas for the lower third on the test 8.8 per cent of the fixations fell on this area of the picture. For the same picture the rectangles that received the most attention from all subjects, namely, Rectangles 6 and 10, received from the upper quartile group 30.6 per cent of all their fixations, while from the lower group these two rectangles received 38.3 per cent of all their fixations.

Random differences such as those just described could be cited in considerable number, but the writer has been able to discover no consistent pattern of difference when all of the results are considered together. The conclusion to which he is forced, therefore, is that rank on an art test or experience in an art school does not affect the perceptual pattern in looking at a picture enough to make apparent any characteristic differences between the two groups.
HOW PEOPLE LOOK AT PICTURES

It is possible that the methods of classifying the groups are not sufficiently valid to make apparent real differences that may exist. However, no better methods of classification were available for this investigation nor does the writer know of any other objective method to suggest by means of which subjects for such an experiment might be classified more precisely in terms of artistic ability or lack of ability. The differences, whatever they may be, which exist between persons with and without artistic ability evidently exist in the central processes of the mind rather than in the perceptual pattern of the eyes. In view of the differences which are so easily apparent between mature and immature readers, both of the vernacular and foreign languages, this conclusion to which one is forced from the data at hand is in no sense satisfactory and must be considered as tentative.

COMPARISON OF CHILDREN AND ADULTS

The comparison of children and adults was based mainly upon two pictures: Picture 34, two French mannikins, and Picture 12, “The Solemn Pledge.” The eleven subjects used were from the sixth grade of the elementary school, with the exception of one child from Grade IV.

Table X shows the data in regard to duration of fixation pauses for Pictures 34 and 12. For Picture 34 average duration for the entire group of adult subjects was 9.2 thirtyths of a second, whereas for the children it was 10.2 thirtyths. However, for Picture 12 the corresponding averages were 10.6 thirtyths for fixations by the adults and 9.5 thirtyths for fixations by the children. In one case the average duration for the children was shorter; in the other case the average for the adults was shorter.

In the previous discussion of duration of fixations it was pointed out that for the entire group of subjects there was a tendency for the fixations to get longer as the subject continued to look at the picture. This tendency is also apparent with children. For Picture 34 the children showed an average of 7.9 thirtyths of a second for the first fixation, an average of 7.6 for the first five fixations, 8.6 for the second five, and 10.6 for the last five. For Picture 12 the corresponding averages for the group of children were 5.5, 8.6, 8.1, and 10.2.

If one may judge from duration of fixations, children at the sixth-grade level show substantially the same characteristics as adults. In the case of reading, children make longer fixations than adults and the process of learning to read is characterized by a negatively accelerated shortening of the duration of fixations. However, in the process of reading most of this learning takes place prior to the sixth grade. There is apparently no evidence of a similar process of “learning” to look at pictures, at least as far as sixth-grade children are concerned. It is difficult to photograph the eye movements of younger children, due to the fact that they do not sit still for a sufficiently long period of time. The type of head movements which young children make are particularly disturbing for vertical fixations. The head rest could be tightened sufficiently to hold them still, but if this were done their reactions would scarcely be normal. One eight-year-old child was photographed in looking at Picture 5, “The Grief of the Pasha.”

TABLE X

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>TYPE OF SUBJECTS</th>
<th>NUMBER OF SUBJECTS</th>
<th>AVERAGE DURATION OF FIXATIONS</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Entire Fixation Pause</td>
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<tr>
<td>34</td>
<td>Adult</td>
<td>26</td>
<td>9.2</td>
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<tr>
<td></td>
<td>Child</td>
<td>10</td>
<td>9.2</td>
</tr>
<tr>
<td>12</td>
<td>Adult</td>
<td>73</td>
<td>10.2</td>
</tr>
<tr>
<td></td>
<td>Child</td>
<td>12</td>
<td>9.5</td>
</tr>
</tbody>
</table>

His record is shown as Plate LXIV. He showed a tendency to look off the edge of the picture several times, his eleventh and twelfth fixations falling so far above the picture that they are not recorded on the plate. It is interesting to note that not until the twenty-ninth fixation was there any detailed examination of the tiger. This particular boy was evidently more interested in the architectural characteristics and decorations in the building than in the animal. The durations of fixations, as indicated on the plate, were brief, the longest fixation being 16 thirtyths of a second. The average duration for the entire picture is 7.1 thirtyths of a second. The adult average for the same picture is 8.9.

PERCEPTUAL PATTERNS OF ORIENTAL SUBJECTS

In view of the differences between Oriental and Western art an attempt was made to compare the perceptual processes of a group of Oriental subjects with those of American subjects. Certain difficulties were encoun-
tered which makes the comparison less significant than it was hoped it might be. In the first place, the number of Chinese and Japanese subjects available was limited. In the second place, a good many who could be secured wore glasses and were not able to look at pictures normally without them. In the third place, some of the subjects who were used did not hold their eyes open sufficiently wide to get a good photograph. Consequently, valid records which could be plotted accurately were secured from only six of the Oriental subjects. The pictures used were the two Japanese prints, Pictures 13 and 14. The number of cases is too small to attempt to treat them statistically. A comparison of the plotted records shows no consistent difference between the Oriental subjects and the American subjects. In the case of Picture 13, “The Wave,” each of the Oriental subjects who looked at this picture concentrated somewhat more than was typical of the American subjects upon some one point in the picture. However, the point of concentration was different for different subjects, one of them concentrating on the snow-capped mountain, a second one making a large cluster of fixations at the crest of the wave, and a third finding the principal center of interest in the left central part of the picture. For Picture 14 this characteristic of concentration was not particularly obvious, and if the plottings for the Oriental subjects were mixed with those of the American subjects, it would be impossible to identify, simply by looking at the plottings, which belonged to either group. If there is a difference in pattern of perception between Oriental and American subjects, it was not revealed in the data available in this investigation. Likewise, in duration of fixations the Oriental subjects showed no marked deviation from the American subjects.
CHAPTER VI
VARIATIONS IN PERCEPTION DUE TO DIRECTIONS FOR LOOKING AT PICTURES

The mental "set" obtained by the directions given for looking at a picture obviously influences the characteristics of the perceptual process. Several types of directions were used in this investigation. In general, the subjects were told simply to look at the pictures in their normal manner, whatever that was. However, in certain special cases the directions were varied to see the particular effects obtained.

Plates LXV and LXVI show two records of the same subject in looking at Picture 43, the Tribune Tower. Plate LXV was obtained in the normal manner without any special directions being given. After that record was secured, the subject was told to look at the picture again to see if he could find a person looking out of one of the windows of the tower. Plate LXVI shows the results of this detailed search. By tracing the lines of successive fixations the trend of this searching movement can be observed. It is apparent that the subject made a very detailed examination of the tower, digressing once to look at the clock tower at the left of the picture and digressing three times to look at the people in the lower part of the picture. In the first picture, Plate LXV, there are only 2 of the 52 fixations which are 20 or more thirtieths of a second in duration. In the second picture, Plate LXVI, there are 13 out of 107 fixations which are 20 or more thirtieths of a second in duration. In Plate LXV there are 25 of the entire 52 fixations which are 7 or less thirtieths of a second in duration, whereas in Plate LXVI there are in the first 52 fixations only 16 which are equally short. The change in directions to look carefully for a given characteristic of the picture produced a much more detailed examination and also longer fixations.

A second variation in directions for looking at pictures was obtained by having one group of subjects look at a series of pictures without any special directions after which they were given a page of comment on the pictures which they had just observed. Following their reading of this body of descriptive material a second photograph was taken of their eye...
movements. The page of material was designed to arouse interest in particular parts of the picture and to stimulate a somewhat different type of observation. The situation was alternated so that for some pictures the subject first looked at the picture, then read the descriptive material, and then looked at the picture again; whereas for other pictures the descriptive material was read before the picture was observed at all. The results of these comparisons can be obtained in numbers of fixations made on the picture, which is an indirect measure of the degree of interest in it, since the subject was permitted to look at it as long as he wished. Also, comparisons are made in terms of the average duration of fixation pauses in the two cases, and in the centers of interest before and after reading.

Records for Picture 11, “The Judgment of Paris,” and Picture 12, “The Solemn Pledge,” showing eye movements before and after reading were obtained from a small group of six subjects. For Picture 11 the average duration of fixations before reading was 9.6, while after reading the average was 10.7. The corresponding averages for Picture 12 are 12.5 before and 11.00 after reading. Further study will be needed before generalization is possible.

One consistent difference which appeared was the tendency to look at the picture for a longer time after the reading. For Picture 11 the average number of fixations before reading was 61.3, while after reading the average number of fixations was 108.8. The corresponding averages for Picture 12 are 77.0 and 91.8.

A third general direction of a different sort was used for Pictures 37 and 38, in which case the subject was asked to choose which of the various panels he liked best. The reaction of subjects to these pictures has been described in an earlier chapter. In order to clarify the effect of the directions a tabulation was made of the number of fixations upon each of the panels as compared with the one which the subject said he liked best after he had finished looking at the pictures. As would be expected, there were more fixations upon the panel which was preferred in the majority of cases, although notable exceptions were apparent, such as Subject 10 who gave over twice as many fixations to one panel which he did not like than to the one which he preferred.

One additional item of the study had to do with eye movements in looking at a series of three advertising posters. These posters are shown in the Appendix as Pictures 48, 49, and 50. The posters chosen were se-
lected because they had received awards for special merit in the year in which they were designed. In each case there was a small amount of printing in large type on the poster relating to the object advertised. In view of the fact that the primary purpose of a poster is to advertise, it is interesting to note the relative amount of attention given to the picture and to the printed material. The plotting shown in Plate LXVII is typical of those obtained from the three posters. As would be expected, the picture of the girl was the principal center of interest. Not until the twelfth fixation was any attention given to the car which is advertised and then for a brief succession of three fixations. The eye returns again to the printing for Fixation 21, but swings back to the girl's face and hair on Fixation 27. On Fixation 32 the eye once more returns to the printing, but only for the one fixation.

The technique of photographing eye movements in looking at advertising pictures has obvious advantages, both for the art designer and for the advertiser. It is assumed that the purpose of the picture in an advertisement of this type is to catch and hold the attention until the eye is lead to the description of the material to be sold. Obviously, a certain amount of balance is desirable between these two elements. In terms of the extensive use to which a single poster is often put the reactions of a sample group of subjects, selected from the class of individuals to whom the advertisement is supposed to appeal, would be of great value in the selection of picture advertising. There is a great variety of problems in the field of commercial art to which this type of technique might be applied to advantage.
CONCLUSIONS

CHAPTER VII

CONCLUSIONS

THE interpretations of the data which have been presented in the foregoing chapters must be left for the most part to those who are competent in the field of art. From time to time in the report the writer has discussed the significance of the evidence presented in so far as it relates to the field of perception which is of common interest both to the artist and the psychologist. Without question the artist will find much of interest in the patterns of perception which relates to problems and theories peculiarly his own. With those problems and theories the writer makes no attempt to deal. The most valuable use of this report will not be derived from a single reading of it, but rather from a detailed and critical study of the many plates which are presented to show the actual patterns of eye movements as different subjects looked at the pictures. These various patterns should contain much of significance for the student of art.

Certain general findings relating to the psychology of perception have already been pointed out. Chief among these are the following:

a) Two general patterns of perception are apparent in the records. One of these consists of a general survey in which the eye moves with a series of relatively short pauses over the main portions of the picture. A second type of pattern was observed in which series of fixations, usually longer in duration, are concentrated over small areas of the picture, evidencing detailed examination of those sections. While many exceptions occur, it is apparent that the survey type of perception generally characterizes the early part of an examination of a picture, whereas the more detailed study, when it occurs, usually appears later. Many subjects in looking at a picture for only a short time revealed none except the general survey type of eye movements. It is probable that most of the visitors to an art gallery look at the pictures with this type of perception and that they see only the main centers of interest.

b) The duration of the fixation pauses increases as one looks at a picture. In view of our general knowledge of the meaning of duration of fixations of the eye this fact is of some significance. Short fixations are apparently related to the simpler processes of visual perception, whereas the longer fixations seem to indicate a mental process of reflection or at least a higher degree of interest than is occasioned by the ordinary survey of the picture.

c) Wide individual differences were found both in the general pattern of perception in looking at a picture and in duration of fixations. In general the differences in duration are more directly related to characteristics of the individuals looking at the picture than to differences in the picture being observed.

d) The effect of color upon the position and the duration of fixations was less striking than had been anticipated. The comparison of eye movements for the same picture, presented once in color and again in black and white, showed somewhat greater attention to those sections where the colors were pronounced, but the differences were less than is generally assumed. It is entirely possible that the effect of color is to be found chiefly in the quality of the mental experience when colored pictures are observed rather than in the pattern of visual perception.

e) The perceptual pattern for various types of repetitive designs showed clearly that the pattern of eye movements does not resemble even remotely the general pattern of the design. The common assumption that the eye moves from motif to motif in the design is not supported by the facts. For ordinary border designs there was a clear tendency at first observation for the eyes to swing to the left end of the design and then to make the first examinations with a left to right series of eye movements. Furthermore, the general assumptions in regard to the rapidity with which the eye is carried along certain types of designs were not supported by the evidence found in this investigation.

f) Comparisons of the patterns of perception for students who have studied art with those of persons who are not specialists in that field revealed some differences, particularly in the matter of duration of fixation. Students who are most advanced in the study of art showed a general tendency to make shorter fixations than did persons who were not so trained. The attempt to make comparisons of art and non-art groups on the basis of their ranking on the art appreciation test failed to show any striking relationships between ability on the test and the characteristics of visual perception.

g) The comparison of a set of records made by a small group of children
with those made by adult subjects showed no consistent differences. The children's patterns of perception, at least for pupils at the sixth-grade level, were quite similar in general to those of adults. Likewise, the duration of their fixation pauses showed no marked contrasts as compared with those of the adult group.

b) The directions given prior to looking at a picture have a marked influence upon the character of perception.

Other factors were studied, but the results were either indefinite or minor in importance and will not be reviewed here.

In general, the significance of the data presented in this investigation rests upon the fact that eye movements are objective symptoms of the perceptual processes of the person looking at a picture. The centers of attention from time to time during the observation of the picture can be located with objectivity and precision from the eye-movement record. While the eye-movement records give no evidence whatever as to the quality of the mental processes going on and are to be considered as in no sense indicative of the type of appreciation experienced by the subject, nevertheless, they do furnish the most objective evidence available of the centers of interest within a picture. If after finishing this report the reader will turn once more to the quoted statements in chapter i, the subjective opinions reproduced there may appear in a different light in view of the objective data furnished in this study. This investigation is, therefore, presented to students of art in the hope that the evidence herein contained may have, when interpreted from their point of view, even greater significance than is apparent to the psychologist without special training in the field of art.
Picture 5.—"The Grief of the Pasha"—Jean Leon Gerome
Size 20.5×26.0 cm. (in color)
Picture 7.—"Outer Ship"—Frederick J. Waugh
Size 23.5×16.4 cm.
Picture 9.—“Stowing the Sail—Bahamas”—Winslow Homer
Size 27.3×17.2 cm. (in color)

Picture 10.—“The Silence of the Night”—William Wendt
Size 27.2×20.4 cm. (in color)
Picture 11.—"The Journeys of Paris"—Walter McElroy
Size 13.3 x 18.5 cm. (in color)

Picture 12.—"The Solemn Pledge—Taos Indians"—Walter Ufer
Size 20.3 x 28.8 cm. (in color)
Picture 13.—"The Wave"—Hokusai
Size 30.2×35.2 cm. (in color)

Picture 14.—Japanese Print—Buncho
Size 19.5×26.4 cm. (in color)
Majoliken. Italien. XV. bis XVI. Jahrhundert. Berlin, Schloßmuseum

PICTURE 17

Picture 15.—Plates, Sugar Bowl, and Pitcher—Sevres, France
Size 24.0×18.8 cm.

Picture 39.—Luster Jar—Mohammedan, Fostat, Egypt, Ninth Century
Size 18.9×24.5 cm.
Picture 21.—GILT BRONZE VASE—CHINESE, FIRST CENTURY
Size 17.8 x 23.1 cm.
Picture 25.—Wrought Iron Stairway
From Charles Moreau, La Ferrométrie Moderne (Paris). Size 20.8×26.6 cm.
Picture 29.—Designs
Size 30.9x3.3 cm. (Shown individually)

Picture 30.—Designs
Size 31.9x2.8 cm. (Shown individually)
Picture 31. — “Joan of Arc”—Henri-Michel-Antoine Chapu
Size 19.6 × 24.8 cm.

Picture 32. — “Amazon”—Franz Von Stuck
Size 15.9 × 23.6 cm.
Picture 33.—Archaeological Pieces
Size 24.0×18.9 cm.

Picture 34.—Mannikins, French
Size 25.6×18.8 cm.
Picture 36.—"The Boar Hunt"—Tapestry, Tournai, Fifteenth Century
Size 17.5 x 23.0 cm.

Picture 35.—Model Sailing Vessel and Crew—Tomb of Mein Event
Size 23.8 x 0.4 ft.
Picture 38.—Woven Designs
From Farbige Meisterwerke. Size 27.2×17.3 cm. (in color)
Picture 39.—Coverlet—American, 1833
Size 17.3×23.3 cm.

Picture 40.—Entrance to the Rosenwald Museum of Science and Industry, Chicago
Size 18.3×23.3 cm.
Picture 47.—A Cathedral Interior
Size 18.0 x 23.3 cm.

Courtesty Underwood and Underwood
**Picture 49.—Poster**

Size 18.3×8.2 cm. (in color)

*First Prize: by Otis Shepard through Campbell-Ewald Company. Lithographed by Edwards & Deutsch Lithographing Company*

*Courtesy General Motors Corporation*

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**Picture 50.—Poster**

Size 21.1×9.1 cm. (in color)

*Honorable Mention: By Otis Shepard through Chas. W. Wrigley Co. Lithographed by McCandlish Lithograph Corp.*

*Courtesy William Wrigley Company*
APPENDIX B

METHOD USED FOR SCORING ART TEST

The method of scoring prescribed by the author of the test consisted in counting one point for each picture numbered correctly. That is, if on one plate a subject rated Pictures A, B, C, and D respectively as 4, 2, 3, and 1, when the correct ratings were, respectively, 1, 3, 2, and 4, the subject would receive a score of 2 for that plate, since Pictures B and C were correctly numbered. A subject rating the same pictures 2, 1, 4, 3, would receive a score of zero, since in no case did his numbers agree with the correct ones. A subject whose numbering agreed perfectly received a score of 4 on the plate.

This seemed an inadequate method of scoring for this reason. In rating a group of four pictures as 1, 2, 3, 4, it is necessary to make the following judgments: A is better than B; A is better than C; A is better than D; B is better than C; B is better than D; C is better than D. Judgments on six relationships are, therefore, made in arranging the four pictures on one plate in order of merit. The method of scoring used in this study gave one point for each of the relationships judged correctly, making a possible score of 6 for each plate. Thus, the first subject cited above who numbered as 4, 2, 3, 1 a plate, the pictures of which should have been numbered 1, 3, 2, 4, had judged correctly that B is better than C. He had judged incorrectly that B is better than A; C is better than A; D is better than B; D is better than A; and D is better than C. He, therefore, made a correct judgment on only one relation and was given a score of one out of a possible six. The second subject cited above who rated the same pictures 2, 1, 4, 3 had judged incorrectly that B is better than A and that D is better than C. He had judged correctly that A is better than C; A is better than D; B is better than C; and B is better than D. He, therefore, received a score of 4 out of the possible 6. The total of the scores on each of the 36 plates used was the score on the test. The total possible score was, therefore, 216.
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