A STUDY OF AFTER-IMAGES

Influences of the After-image on Memory and Perception

by

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PREFACE

The writer wishes to show his appreciation to Dr. D. McL. Purdy who suggested the problem and method of investigation; Dr. Harry R. DeSilva for his supervision and criticisms during the absence of Dr. Purdy; Dr. R.H. Wheeler whose review, suggestions and criticisms were of value; Dr. Warren Wilcox for permitting the writer to use his apparatus for producing a visual field of calibrated brightness; and to the many observers who so willingly gave of their time. Miss Clara Hilderbrandt is to be commended for her work in typing this manuscript.

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I. INTRODUCTION

The possibility that the persistence of sensation effected memory was noticed by Wundt[1] in tachistoscopic tests. James[2] also pointed out the probable influence of after-images in his "Psychology" in which he stated, "We shall probably never know just what part retinal after-images play in determining the train of our thoughts. Judging by my own experience, I should suspect it of being not insignificant." From close observation these psychologists recognized the problem of the influence of memory by retinal after-images. The problem arises as to the nature of this influence. Is this influence confined to persistant after-images in the field of vision alone? Does the after-image increase or decrease memory? In what manner is this influence effected?

The educational psychologist, in his effort to find the best method for presenting material to be learned in school room situation has failed to recognize the influence of persistant after-images upon memory and upon the perception of succeeding stimuli. A better knowledge of these influences of persistant sensations upon the sense receptors and upon memory should aid these psychologists in their control of variable conditions.

According to Gestalt principles of psychology, we should expect that persistant sensations in a sensory mechanism would mean greater disturbance, tensions, within the neurological processes than a sensation not so persistant. Likewise, it is to be expected that persistant sensations influence the perception of succeeding stimulation to that sensory mechanism. It is the purpose of this experiment to show quantitatively the influence of the duration of visual after-images upon memory and upon perception.

II. EXPERIMENTAL HISTORY

In 1903, J. P. Hylan[3] made a study of the problem of memory. He assumed that there was a "memory-after-image" which would vary in duration with length and intensity variations of stimulation. He found that changing the intensity of the stimulus and changing the duration of the stimulus he could control the amount of material remembered. He explained this change of memory as the result of different amounts of "discrete attentions which could be given to a "memory-after-image" of varying duration.

Hylan is to criticized for the distinction he made between "memory-after-image" and ocular-after-image. The validity of this distinction is questionable. Can visual processes which are persistant be separated from memory processes which exist at the same time? Can the memory be separated from the physiological processes of the sensory organ? It is the writer's contention that the two questions must be answered in the negative. One process is dependent upon the other and therefore, must be an integral part of a system which is greater than both Hylan's assumptions of "discrete attentions" upon a "memory-after-image" is analogous to looking at your face with your own eyes without the aid of an external agent. He did not recognize the possibility that the ocular-after-image and the memory-after-image are differnent levels of a defferentiation process within the visual mechanism. The implications of this experimental evidence was overlooked because of his assumption of a "memory-after-image".

Spearman[4] published a posthumous article by W. Lange on the difference in speed of rotation of a color mixing disc just prior to fusion for perseverators and non-perseverators. He found a positive relationship between low speeds of rotation and perseverators and high speeds of rotation and non-perseverators.

Lange's division of observers into two distinct groupings, perseverator and non-perseverator, is questionable. From the writers experience with eighty-five observers such a definite classification could not be accomplished unless by arbitrary distinction. Individual differences in the amount of perseveration are found among the observers, but none of them could be classified as non-perseverators.

Wiersma[5] measured the time required for dark adaptation when the observers are taken from a light to a dark room and correlated that time with the speed of rotation of color discs. He found a positive relationship between low periods of adaptation and low speeds of rotation for fusion of colors. Wiersma's work was criticized by Heyman and Brugum because he used abnormal subjects. They repeted his experiments using normal subjects and found evidence supporting Wiersma's work. The writer criticizes this work because of poor technique. The light adaptation of each subject was not controlled as the brightness varies from day to day.

G. H. Miles[6] studied the retention of the "projected image" in connection with visual memory. This is the first attempt to measure the duration of the after-image and compare it with visual memory. He had his observers work on a chart the position of the parts of a picture which was presented them. The picture was first presented separately. He found a positive correlation between the length of the "projected image" and the accuracy of judgment.

The exp rimenter has repeated Miles' work, improved upon the technique for producing after-images and confines the stimulus area within the limits of the fovea. Memory tests were employed in which the observer used, in one case verbal and visual memory and, in the other test, only visual memory.

LEGEND

Apparatus for Producing After-images.

H. Hood of apparatus which shields the observer from scattered light.

F. Fixation points and lamp.

LB. Light box.

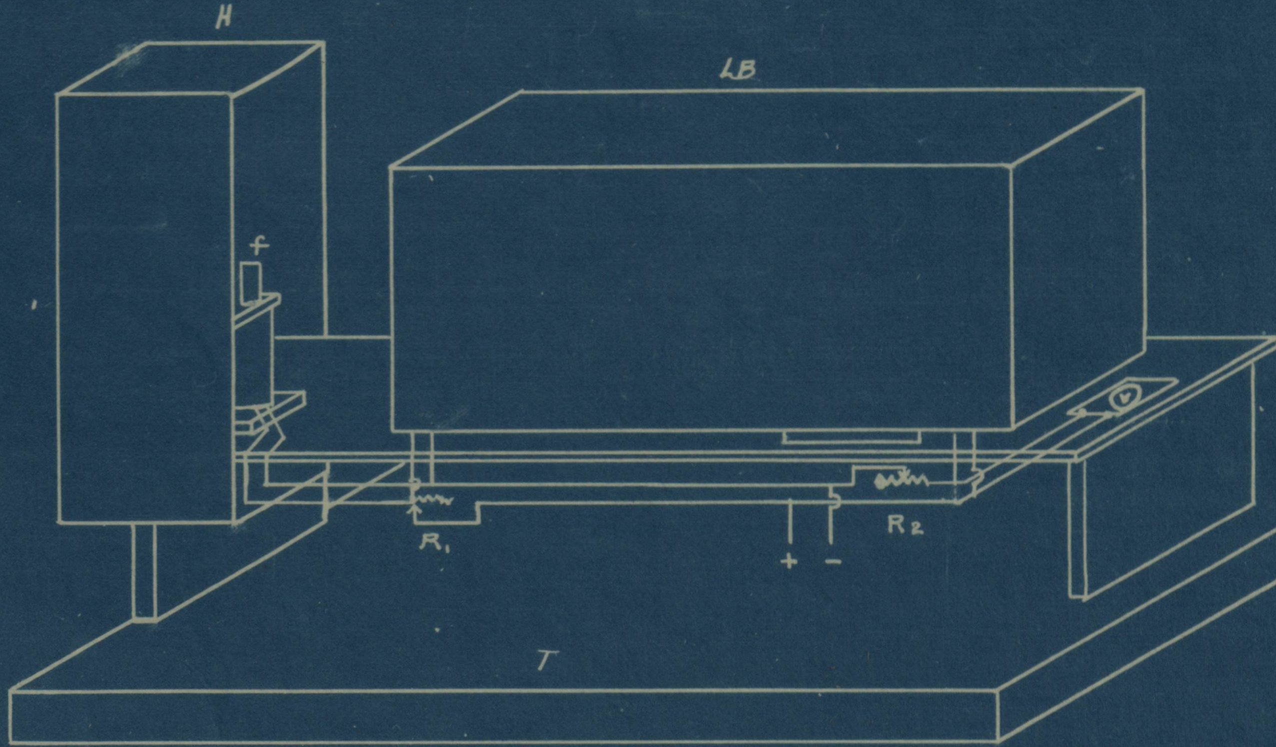
$R_{.1}$ Rheostat controlling voltage to fixation lamp.

$R_{.2}$ Rheostat controlling voltage to stimulus light source.

T. Table on which apparatus was placed.

Figure 1

Apparatus for Producing After-Images



LEGEND

Apparatus for Producing After-image

E. Observers eye.

P. Artificial pupil, diameter .076 inch.

F. Fixation points.

L. Concave lens, eight diopter.

A_2. Diaphram with opening .076 inch in diameter.

S. Eastman kodak shutter timed for half second exposure.

R_1. Rheostat controlling brightness of the fixation points.

L_1. Convex lens, eight diopter.

R_2. Rheostat for controlling the brightness of light stimulus for the after-image.

LS. 600 watt lamp producing light source.

Apparatus for Producing After-Images

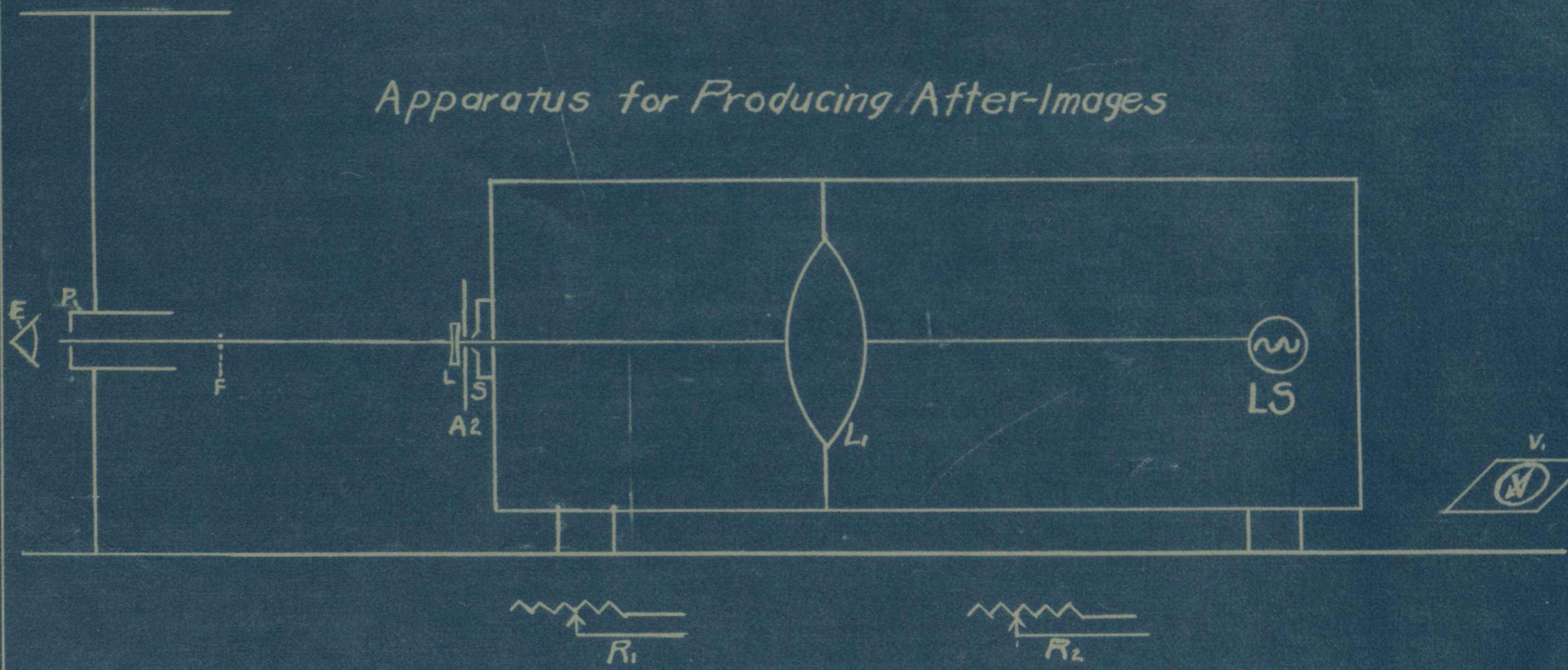


Figure 2

LEGEND

H. Front view of hood.

1. Artificial pupil.
2. Head rest.
3. Chin rest.

O. Observers seat observation of after-image.

O_1 Observer's seat for production of after-image.

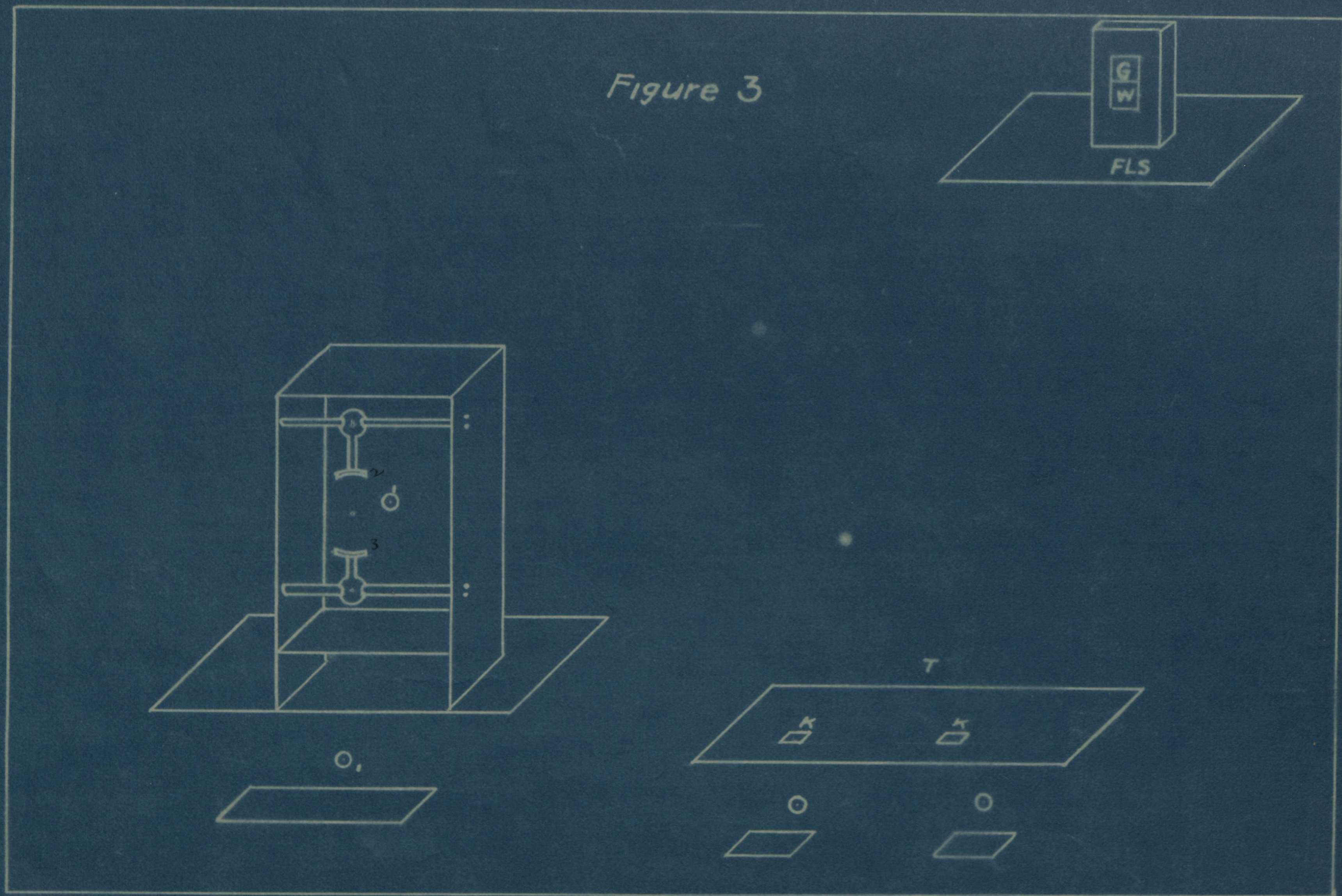
K. Signal key by which observer indicated the disappearance of his after-image.

FLS. Fixation field on which after-image was projected.

G. Green half of the field.

W. Orange half of the field.

Figure 3



III. APPARATUS AND METHOD OF INVESTIGATION

I. Preliminary Investigation

A. Experiment Measuring the Duration of the After-image.

(a). Apparatus.

The apparatus was constructed for the stimulation of an area within the fovea by a small, intense light traveling in parallel rays. Figure I gives a sketch of the side view of this apparatus. This drawing shows (H) a hood which protected the observers eyes from scattered light in the room, a head rest, chin rest and an artificial pupil; (F) a device which defined a limited fixation area; and (LB) a light box containing a system of lens, diaphrams, and Eastman kodak shutter and a lamp. In figure II a vertical cross-section of the apparatus is drawn which shows (E) the position of the observers eye, (R) the artificial pupil .076 inch in diameter; (f), the fixation points; (L), a concave lens; (A_2), a diaphram .076 inch in diameter; (S) the shutter which controlled the exposure time; (L_1) a convex lens; and (LS) the 600 watt lamp which produce the light source. This lamp was operated by means of a 110 volt direct current. The front of the hood, (H); and the observers position for receiving stimulus and for projection of image is shown in figure III. (T) the table at which the observer sat fixating a field

(FLS) of constant brightness. This field was composed of two colored areas, green and orange. By fixating the green field the observer to perceive his after-image. When it disappeared from view he shifted to the orange field and the change of brightness reinduced the after-image. The changes were made until the after-image could no longer be reinduced. The time from the end of the stimulus until the after-image was no longer seen was the time of the duration of the after-image of that individual.

The observer, in order to receive his stimulus, sat at (O) in front of the hood (H), adjusted the head and chin rest to suit his condition and looked through the artificial pupil with his right eye. In this position he could view a small area outlined by four points of red light made by the fixation lamp (F), figure I. He was instructed to focus on the middle point of the area so that when a light stimulus appeared in the middle of this area he would not have to move his eyes to fixate the stimulus. With some practice the observer became familiar with the correct place to focus the stimulus. After the stimulus was received it was necessary for the observer to move four feet to the table (T), figure III, to fixate the illuminated field for the projection of the after-image. When the observer perceived his after-image had disappeared he pressed a key (K) and the experimenter noted the time on a stop watch which he had started at the end of the stimulus for that observer. The length of the persistance of the sensation was approximately constant for the observation of the stimulus on different days. The stimulus was given for one half second.

The observers were students from the General Psychology Laboratory classes. There were thirty five in all used throughout the preliminary investigation.

(b) Results.

There were many individual differences in the duration time of the after-image. The length varied from no after-image to after-images lasting 108 seconds.

LEGEND

Apparatus for Producing Three-light Stimulus Pattern

A. Light stimulus apparatus as seen by observer.

(a) The rotable disc.

(b) Holes in the face of box for constant part of stimulus pattern.

(e) Opening in disc to promit the hole in the face of the box to be exposed.

B. Light stimulus box with disc removed.

(o) The twenty holes in face of apparatus relatively placed as on apparatus.

C. Light stimulus box with top removed.

(c) rotable disc.

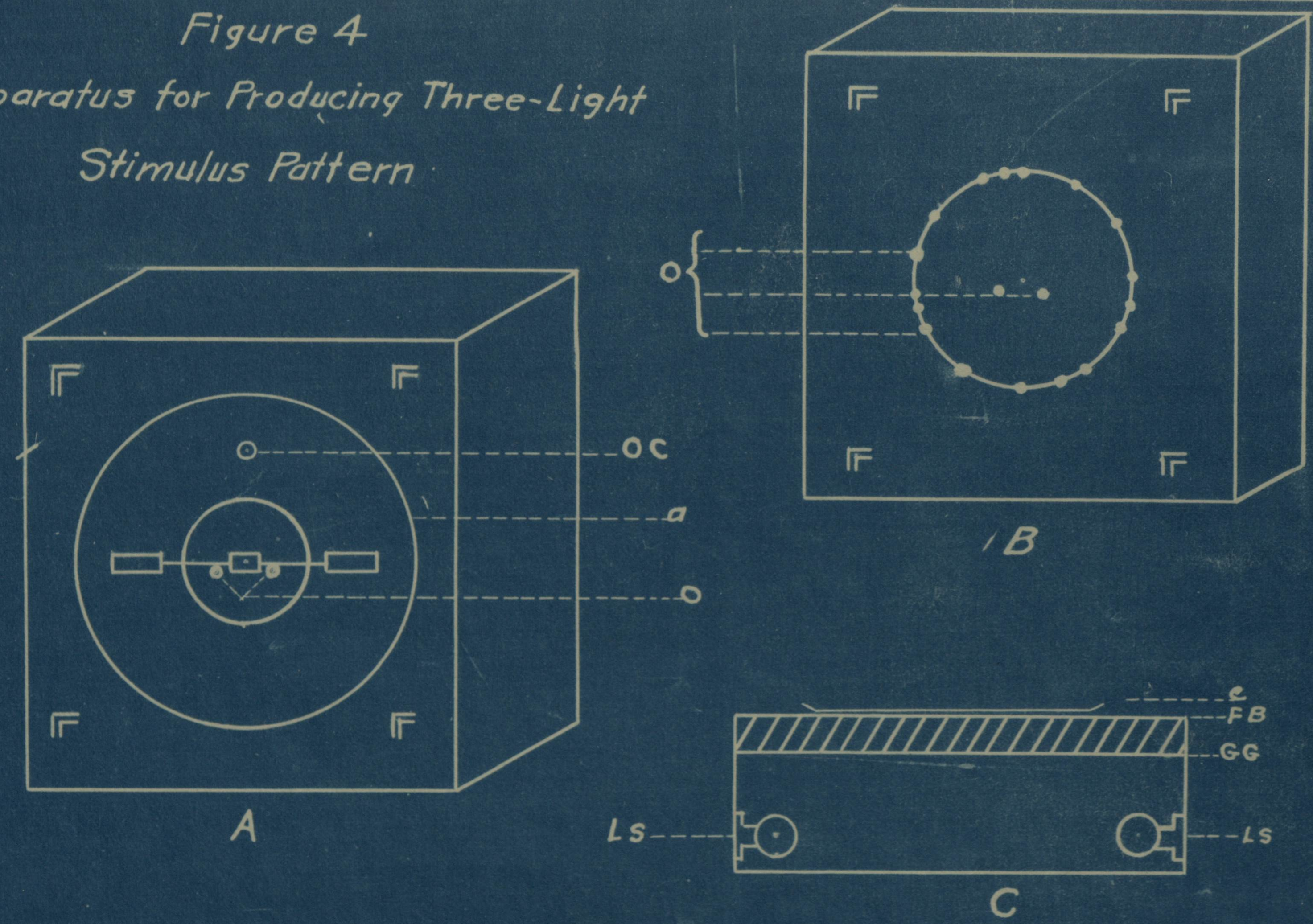
(FB) Face containing holes.

(GG) Milk glass to scatter light for approximately even illumination of all holes.

(LS) Two of the four light sources.

Figure 4

Apparatus for Producing Three-Light Stimulus Pattern



LEGEND

Memory Chart

1. Method of making chart.

(a) and (b) Spots representing the constant part of stimulus patterns.

Name------------------------

Date -----------

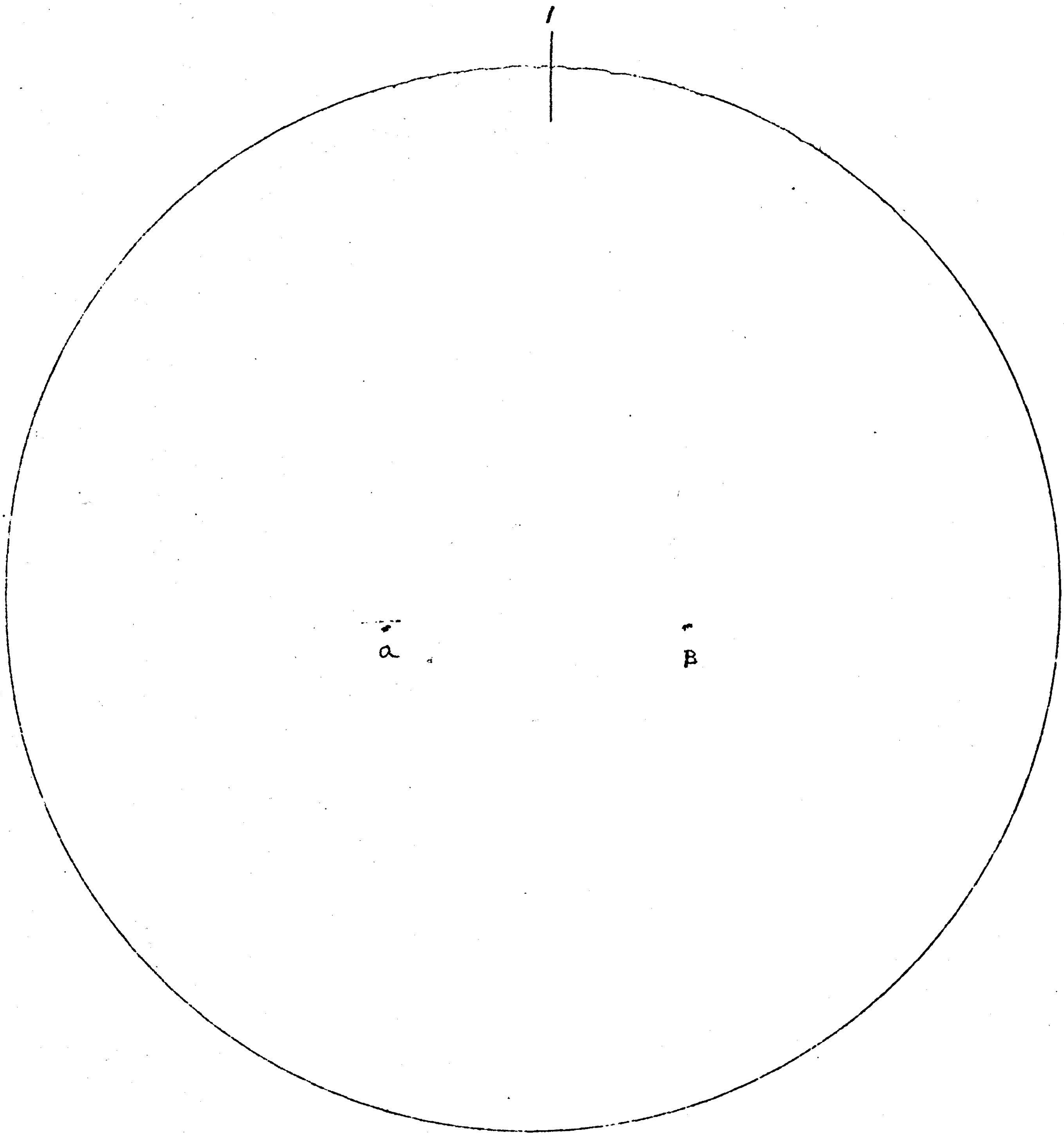


Figure V

Clendenon

B. Experiment Measuring the Accuracy of Memory

(a) Apparatus and Method.

This experiment required the observers to remember the position of one of the three small light sources with respect to the position of the other two which were worked on a chart. The stimulus pattern was produced by a light emanating from twenty small holes in a light box. Eighteen of these holes were placed on the circumference of a circle and the other two on opposite sides and a little below the horizontal diameter. The eighteen holes were covered by a disc with an open sector which exposed only one of them at a time. The two holes near the center were always in view.

Figure IV is a drawing of this apparatus. (A) as the apparatus appeared to the observer, (B) as it appears with the top of the light box removed viewing it from above. This box was illuminated with four sixty-watt lamps. Between the face of the box and the lamp is a milk glass screen which difuses the light approximately even to all the openings. This apparatus was built to expose three of these holes for one stimulus pattern. Two of these were the holes located in opposite sides and slightly below the center. The two holes were a part of every stimulus pattern. The third hole which was exposed was one of the eighteen placed on the circumference of a circle.

These eighteen holes varied irregularly between ten and twenty five degrees of the circle from each other.

The observers were given a chart which corresponds exactly with figure V. This chart contained two spots, (a) and (b), which were exactly the same distance from the center and in the same position as those on the apparatus. The chart was to be marked as (1) for the location of the third spot of light exposed by the experimenter. The circle on the chart corresponds exactly with the circumference of the circle upon which the eighteen holes were made in the apparatus.

The observers were seated facing the cloth covered light box, given a chart and read the following instructions: "You have been given a chart consisting of a circle with a dot to the right and a little below the center, also a dot similarly located on the left of the center. In the proper spaces at the top place your name and day of the month.

"I will operate an apparatus which has two spots of light located in the same position as which you see on your chart. This device will present a third spot of light which will correspond to some point on the circle on your chart. You are to think of these spots of light as the pattern of a triangle, having two spots of light, which correspond to the dots on your chart or the base of the triangle and the third spot of light corresponding of some point on the circle as the apex of the triangle.

This triangular pattern of three spots of light will be presented to you for six seconds. You are to fixate this stimulus pattern during its presentation. When the stimulus is removed you will be given three seconds to record your judgments. "Is everyone certain of what he or she is to do?" ---- an illustration of method of scoring chart was given---- "The signal ready will be given before each presentation of a stimulus pattern."

At another time the same experiment was repeated with this change in the instructions. "You are going to repeat the experiment of the three spots of light. This time you are not to record your judgment immediately but wait until I give the signal record ---- "This signal was given after an interval of two minutes ---- "Do not hold your pencil or finger on the chart to indicate the location of the third dot."

In order to control the condition of the mental processes of all observers the interval was filled by a discussion or story of interest to all.

The error of judgment was measured on both charts by the angular degrees diviation from the exact center of the position of the light spot as it would be if the chart were held against the face of the apparatus. The total number of angular degrees of error constituted the score on each chart.

(b) Results of the preliminary investigation.

By correlating the duration of the after-image for each observer with the score he made on the first memory tests in which the stimulus patterns were presented consecutively with only time between for recording, a coefficient of .23 was obtained. Probable error was .1. For the correlation of the duration of the after-image with the score made on the second chart in which delay of two minute intervals was interposed between stimulus pattern and recording of judgment a coefficient .43 was obtained. Probable error was .07. The product-moment method was used in computing the correlation coefficients.

LEGEND

Apparatus for Producing After-images

E. Observers eye.

P. Artificial pupil, diameter .076 inch.

A. Diaphram diameter .078 inch.

N. Neon lamp.

MD. Magnesium oxide covered sector disc.

L. Eight diopter concave lens.

A_2. Diaphram, with opening of diameter .076 inch.

S. Eastman kodak shutter time for one second.

R_1. Rheostat controlling voltage to Neon lamp.

R_2. Rheostat controlling voltage on light source.

L_1. Eight diopter convex lens.

LS. 600 watt lamp, light source.

Apparatus for Producing After-Images

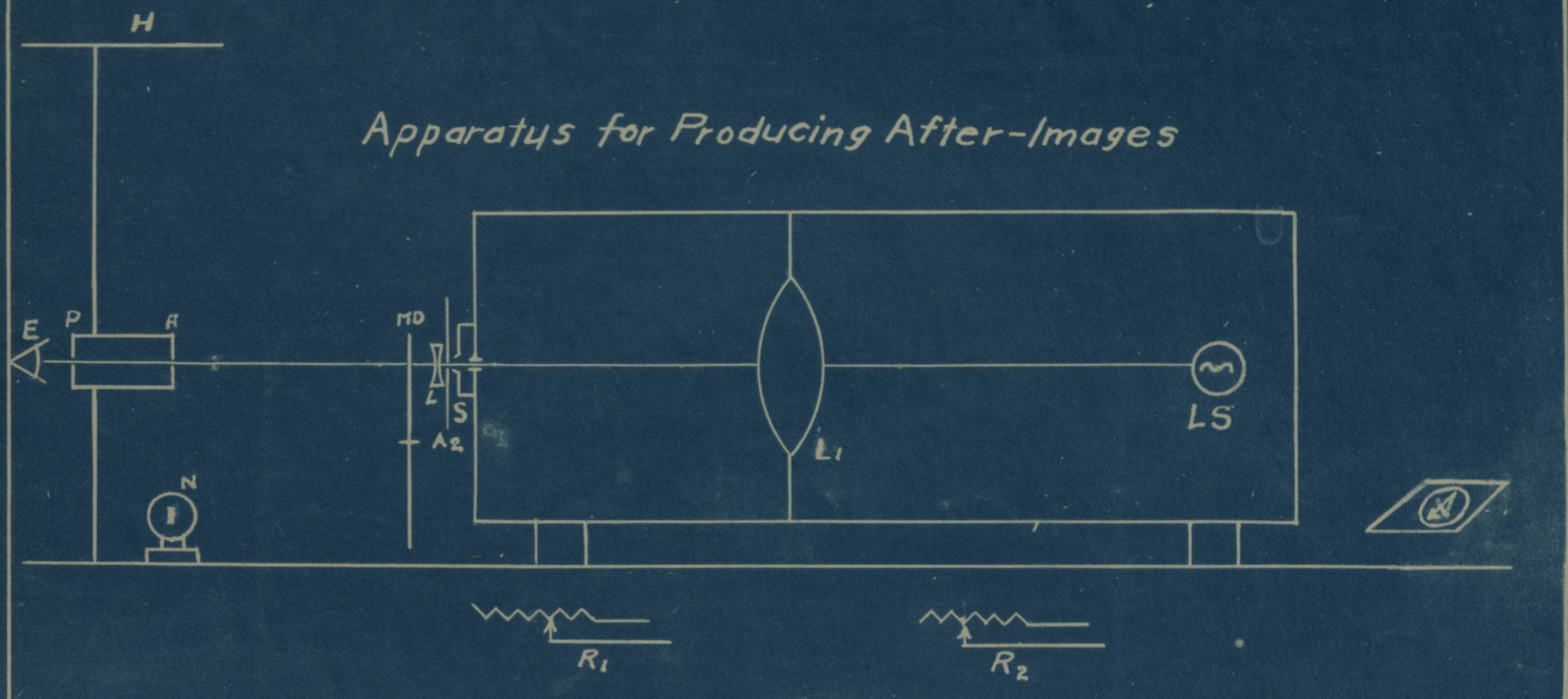


Figure 6

2. Final Investigation.

This investigation was conducted with an improvement of apparatus and technique. It repeated the preliminary investigation using fifty observers and added an experiment for a memory test which was void of all verbal symbols to aid the memory.

A. Experiment for Measurement of Duration of After-image.

(a). Apparatus and Method.

The apparatus used in this experiment was the same as used in the preliminary investigation for measuring the duration of the visual after-image except for the following changes. The observer placed his eye at (E) figure VI and looked through artificial pupil (P) .076 inch in diameter. Six centimeters back of this opening was an aperture (A) .078 inch in diameter. Ten centimeters from this aperture, (A), a magnesium oxide coated sector disc was located, (MD), which was illuminated by a neon glow lamp, (N). The observer looking through the artificial pupil (P) in a dark room sees a small pink spot of light which is slightly larger than the light stimulus which produced the after-image. This pink spot of light reflected from the sector disc was used as a standard illumination for adaptation of the retina affected by stimulus light, as a fixation spot and as a background upon which the after-image is observed. Two centimeters back of the sector disc (MD) is eight diopter concave lens (L_2).

Against this lens (L) is an aperture (A) .076 inch in diameter. Two centimeters beyond this aperture is a Eastman kodak shutter (S) which is timed for an exposure of one second. This shutter is fastened in the face of the light box (LB) which contains an eight diopter convex lens(L_1). Located twelve centimeters from the shutter and forty centimeters from the light source (LS), a 600 watt lamp operated on a 110 volt direct current. This arrangement produced a strong .076 inch diameter circular light stimulus of parellel rays upon the retina.

The observers were instructed to fixate steadily the spot of pink light reflected from the magnesium oxide disc. Each observer was given three minutes for adaptation to that fixation spot. Just prior to the stimulus the fixation field was removed, the stimulus given and the field replaced. After the stimulus was given the observer was instructed to continue fixation of the fixation field, to report when the after-image appeared, the form of the after-image and where it appeared with respect to the fixation light. If the observer reported the after-image as being any shape other than a small circular spot with a diameter of approximately one millimeter or if it did not appear within the fixaion field, the observer was not in direct line of vision with the light source at the beginning of stimulation and moved his eyes during the stimulation. This stimulus was not counted as the proper stimulation for the production of the after-image and the duration time was not considered the correct one. Helmholtz pointed out the fact that multiple after-images could be produced by eye movement during stimulation of the eye with light. If the observer reported the after-image as lying in front of, out in space, the fixation spot, or on the fixation spot and a small circular image, the experimenter was certain that the stimulus had fallen within the fovea and was a stimulation of only one small area of the retina. It was the aim of the experimenter to stimulate each observer on one small area of the fovea for the same length of time. By means of the previously mentioned criteria the experimenter was able to ascertain whether each observer received the same stimulation. Because of physiological imperfections in the eyes of some of the observers, such as astigmatism, far or near sightedness, it was impossible to produce precisely the same stimulation upon the fovea of all observers. This factor may have effected appreciably the extent of the duration of the after-image. All of the observers were untrained in visual experiments. Only two of the fifty subjects used in the investigation had ever examined closely a visual-after-image. It was necessary, therefore, to demonstrate to each observer the appearance of the after-image, how it would disappear upon voluntary movement of the eyes, and to attempt an explanation for the movement of the after-image over the fixation field, and which occassionally moved out into space. The length of duration of the after-image was the average of the three after-images taken each on different days when these lengths became so constant as to not vary more than three seconds of each other for each observer. The experimenter found that when the physical conditions were exactly the same the after-image for each observer was approximately constant. Among my observers were five who showed tendencies of belonging to the eidetic types described by Jaensch. One of the observers exhibited such a strong eidetic-after-image that her results were eliminated. The other four were included in the results of the investigation for they were not sufficiently different from the normal. Two of these four observers, according to Jaensch's classification, might be placed in the memory eidetic type and other two in the after-image eidetic type. For one of the observers of the memory eidetic type, it was impossible to produce an after-image under any conditions known to the experimenter. The observers consisted of twenty males and thirty female subjects. The range of duration of after-images among these subjects varied from zero duration to duration of 185 seconds.

B. Experiment Measuring the Accuracy of Memory

(a) Apparatus and Method.

This experiment was carried out with the same apparatus as used in the preliminary investigation, figure IV. Instead of the observers looking directly at the apparatus was placed at one end of the research room facing a mirror hung on the opposite wall. The observers were given the same chart as figure V and seated facing the mirror. The observers were instructed to record the stimulus pattern as seen in the mirror. With this exception, the instructions to the observers were those used in the preliminary experiment on memory. The method of scoring was by angular degrees of error of a mirror picture of the apparatus stimuli. By having the observers view the stimulus in the mirror, it was easier to operate the apparatus and control the light switch to the lights which illuminated the room. The room a was made dark during the presentation of the stimulus pattern. This method of presenting stimuli in a mirror eliminates any possible physical cues for the location of the third spot of light which might be gained from seeing the apparatus.

(b) Results

1. Correlating the scores made on the memory test with consecutive presentation of stimulus pattern with the duration of after-image for each observer a negative .04 was obtained.

2. Correlating the scores made on the memory test with delayed recording of stimulus pattern against the duration of after-image positive .47 was obtained. The probable error of correlati on was .07.

LEGEND

Apparatus for Producing Brightness Differences

Part A.

A. Mental measuring tape box.

B. Pointer to tape to indicate distance.

C. Point source lamp.

D. Track over which lamp base traveled.

E. Magnesium oxide covered screen.

M. Experimenter's seat.

Part B.

G. Table on which apparatus governing visual angle of stimulus is seen.

I. Two diopter concave lens.

J. Tube holding lens (I) and artificial pupil four square millimeters in area.

K. Hood protecting observer from scattered light.

EY. Location of observers eye.

L. Observers seat.

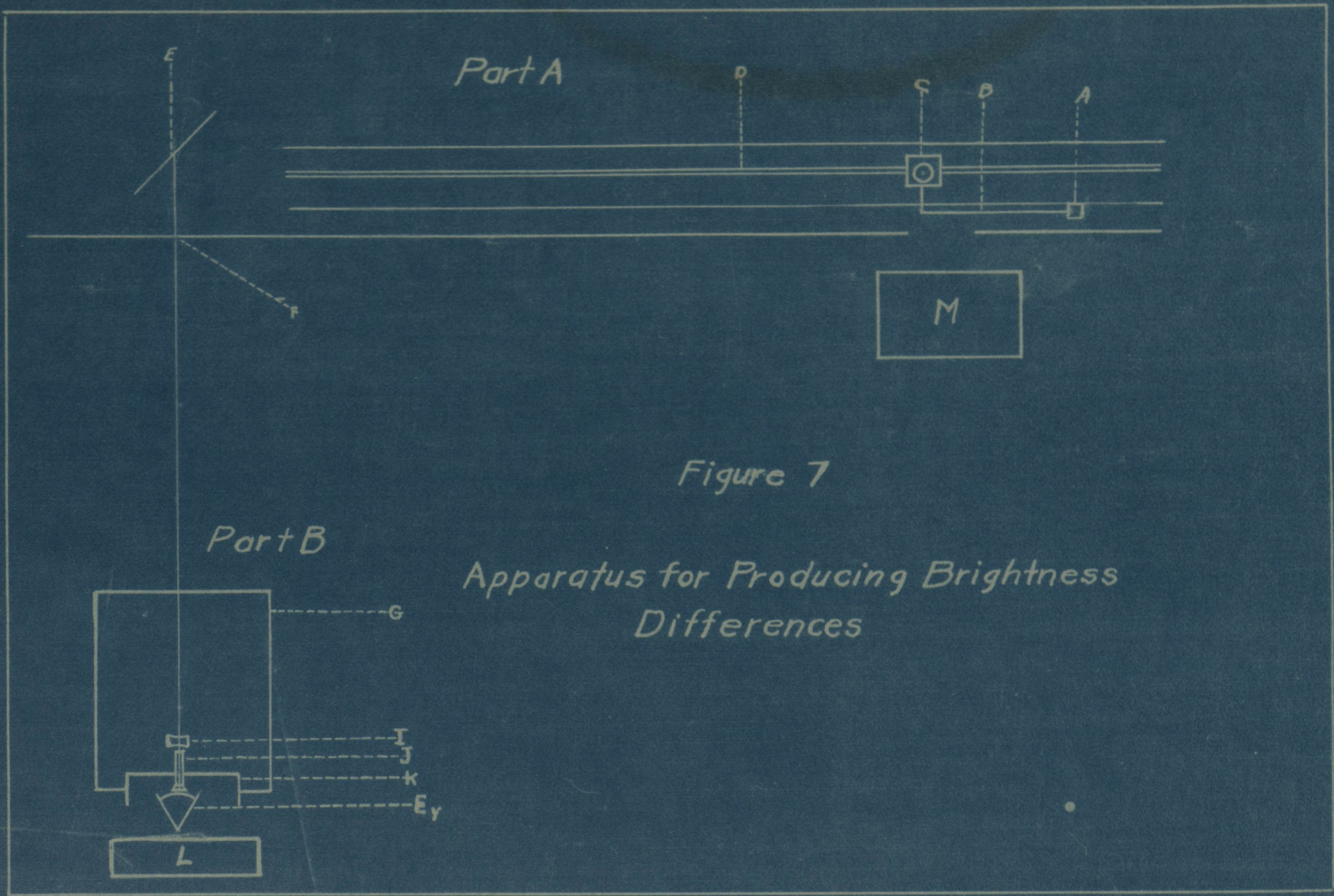


Figure 7

Apparatus for Producing Brightness Differences

C. Experiment Measuring Error of Brightness Memory

(a) Apparatus and Method.

The apparatus for this experiment was constructed so as to present a circular stimulus field two minutes and forty seconds in visual angle. This stimulus field could be varied in brightness from .09 photons to 1.35 photons. Figure VII gives a diagramatic presentation of the apparatus. Part (A) consists of a light tunnel with a track which carries a light bulb--the type used as a pilot light for radios. This light illuminates a magnesium oxide covered plate placed at a 45 degree angle with the light so as to reflect the illumination through a opening (F) 6½ centimeters in diameter, 350 centimeters from (F) is a three diopter diverging lens (I) attached to one end of a tube (J) with an artificial pupil on its other end.

The light that illuminated the magnesium oxide disc was burned at .006 amp., on six volts. It was for all practical purposes a point source and varied the illumination on the magnesium oxide plate proportionately with the square of the distance. The track over which the light traveled was two meters long. The position of the light on the track was measured by a metal tape (A) figure VII.

The observers were seated at (L) and given the following instructions. "You are to view a stimulus of a definite brightness for five seconds which you will see by looking through an opening in the hood. So you see a small circular light? Now I will change the light making it weaker and then gradually increase it. When you think the light is as bright as it was in the beginning, tell me to stop.

The experimentor had a card which contained the observers name and the position on the scale of five standard brightnesses, .16 photons, .23 photons, .43 photons, .76 photons and 1.208 photons. The observers were allowed to view the standards in the order given. The illumination was reduced to .09 photons and gradually increased until observer gave the signal to stop. The two best of the most consistant scores were averaged and the average was used as the basis for his judgment of that particular standard. Rest period of one minute was introduced after each trial to eliminate the formation of after-images of noticeable character of the stimulus as it might influence the judgment of the next standard. The observers were not aware of the number of different standards used. For the two lower standards the observers often reported the difficulty of recognizing a difference. Many said they could tell no difference what ever for the two lowest standards. The highest standard had a distinct yellow tint which aided in the judgment. The stimulus took on this tint just as it was approaching the standard so that the observers had a criterion in it that was not present in the other stimulus standards.

(b) Results.

In correlating the amount of error made in the judgments of each stimulus standard and the length of duration for the after-image, the experimenter found the coefficients of correlation as follows:

Stimulus standard	Coefficient of correlation
1.208 photons	.26
.76 "	.29
.43 "	.22
.16 "	.04
.20 "	.04

The correlation of total error made on this test with duration of after-image gives a coefficient of .43. Its probable error is .07.

IV. SUMMARY OF RESULTS

With the use of the product-moment method of correlation the experimenter has found the amount of relation-ship between the duration of the after-image and the scores made on the memory test.

A. Results of the preliminary investigation when correlated are as follows:

1. The correlation coefficient of duration of after-images with scores made on consecutive presentation of light stimulus consisting of three spots of light -- .48. Probable error -- .07.
2. The correlation coefficient of duration of after-images with scores made on delayed recording of stimulus pattern consisting of three spots of light -- .23.

   These results show a negative agreement between long duration of after-images and accuracy of "consecutive" scores and a tendency toward positive agreement between long after-images and accuracy of memory of "delay recordings".

B. Results of the final investigation when correlated are as follows.

1. The correlation of the duration of after-images with scores made on consecutive presentation and

immediate recording of position of light stimulus is -- .04.

2. The correlation of the duration of after-image with scores made on delayed recording of stimulus pattern -- .47.

3. The experimenter wished to find the correlation of the percentage difference between the score made on consecutive presentation and immediate recording of results and scores made on delayed recording of the stimulus with respect to the consecutive score and the duration of after-image. By this method he wished to show the relative influence of the length of after-image upon memory. The results from such a correlation is .57 with a probable error of .064.

4. By correlating the scores made on judgment of brightness with the duration of after-image, a coefficient of .45 was obtained. These scores representing the amount of error. This correlation shows that the greatest error accompanies long after-images. Several of the observers reported that for the brighter standards of judgment there was an after-image found which persisted for them during the rest periods which were interposed between each judgment.

5. In correlating the duration of after-image with

the amount of errors made on each of the five standards. A positive coefficient of .26 is obtained for the highest standard (this standard had a criterion of color because of the nearness of the light to the magnesium oxide plate. Many observers reported using this tint of color as a guide for their judgments.) for the standard next in brightness, .76 photons, a coefficient of .29; for standard of .43 photons, a coefficient of .22; and for the standard of .23 photons, also a standard of .16 photons, a coefficient of .04.

The memory tests of the position of three lights show that the greater duration after-image does increase the accuracy of judgments of the position in many cases. The experimenter repeated these tests on most of his observers at a later date and found approximately the same percentage difference in scores made on the "consecutive" and "delayed" tests as were found in the earlier tests scores. It is his contention that correlating the percentage difference of "consecutive" score and "delayed" score gives a truer picture of the influence of persistance of sensation upon memory in these tests.

The scores made on the accuracy of memory of brightness when correlated with duration of after-image shows the after-image to decrease the accuracy of the memory of the stimulus. Six of the observers who had extremely long after-images reported that the higher standards of brightness produced after-images. Their judgments of the return of stimulus in their earlier attempts were no better than guessing. Their improvement in judgment was accomplished only when they were made aware of the size of their error. The experimenter encouraged all observers to do their best. Many of them reported not seeing the stimulus reach the position of the standard, but instead, before they realized it, the light appeared too bright. The experimenter tried to have the observer judge by reducing the light. The observers judgments were no better. This shows, conclusively, that the perception of the stimulus was affected.

V. CONCLUSIONS

This experimental results gives conclusive evidence that the visual after-image has an appreciable influence upon memory. This fact is shown clearly when observing the scores made on the test for memory of position of the three-legal stimulus pattern and compare the "consecutive" scores made by observers with after-images lasting from ninety seconds or longer with "delayed" scores. In every case but two there were increases of ten percent to forty percent in accuracy.

The data gathered from the test on memory of light indicate that in this type of test the perceptual pattern is disturbed by the duration of after-image. The intro-spective reports of those observers with long and vivid after-images of the stimulus pattern show a complete blocking of the perceptual processes to succeeding light stimuli.

Among the observers were four who the experimenters classed as eidetic types. Two of these observers might be called, according to Jaesch's[7] clas-sification, after-image eidetic individuals. These two had extremely strong after-images; yet their memories of the light standard was much more accurate than those of other observers who had after-images of nearly the same duration. The experimenter believes that these individuals must have the processes which produce the after-image at a higher mental level of differentiation within the visual mechanism than that occuring in individuals not of eidetic type; that these processes of higher origin do not produce as great an inhitition on the sensations aroused by a stimulus; and, therefore enables them to perceive more accurately the changes of the stimulus until it approaches the brightness of the standard.

This experiment verifies the fact pointed out by Wundt that after-images do influence the memory in tachistoscopic test. Also, in other tachistoscopic experiments, which have shown that beyond a certain duration of exposure memory of the stimulus is decreased in accuracy. Helmholtz has pointed out that these movements of the eye during a light stimulus will each have a separate after-image formed. The composite of these images over-lap and produces a blurred sensation of the stimulus pattern; Thus presenting an indefinite memory of the stimulus pattern.

The educational psychologists must, in his effort to increase the memory span, know the type of individual he is dealing with. He must know, using the classification of Lanke,[4] whether the individual is a perseverator or non-perseverator. It is further necessary for him to recognize the influence of persistant sensation upon the perception of succeeding stimuli and make some arrangement to avoid the disturbance of perception.

VI. BIBLIOGRAPHY

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