72-24,375

LIN, Chen-shan, 1934-
AN EXPERIMENTAL STUDY OF THE VISUAL EIDETIC
IMAGERY OF CHINESE SCHOOL CHILDREN.

University of Hawaii, Ph.D., 1971
Education, psychology

University Microfilms, A XEROX Company, Ann Arbor, Michigan

AN EXPERIMENTAL STUDY OF THE VISUAL EIDETIC IMAGERY OF CHINESE SCHOOL CHILDREN

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE
UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN EDUCATIONAL PSYCHOLOGY

DECEMBER 1971

By

Chen-shan Lin

Dissertation Committee:

Ian E. Reid, Chairman
Peter Dunn-Rankin
Mark P. Lester
Samuel I. Shapiro
Arthur W. Staats

ACKNOWLEDGMENTS

It is a pleasure to acknowledge my gratitude to those who helped me in the completion of this dissertation. I am especially indebted to Dr. R. M. W. Travers of Western Michigan University for his generous advice and encouragement. Thanks are due to Mr. W. J. Chang, Mr. S. Y. Kuo, and the students in my class of Experimental Psychology for their cooperation and assistance in conducting the experiments. A special acknowledgment is also due to the National Science Council for its support of grant, and to the Department of Educational Psychology, National Taiwan Normal University, for its contribution of laboratory spaces and equipments.

ABSTRACT

The purposes of this study were (1) to investigate the incidence of visual eidetic imagery among Chinese school children, and (2) to test Travers' (1970) assumption, which stated that eidetic imagery might be due to a retarded development of erasure mechanism.

A sample of 519 subjects were randomly drawn from a population of 130,000 school children of Grades 3 to 6 in Taipei City. A method similar to that used by Haber and Haber (1964) was adopted to screen the eidetic children from this sample. Results indicated that if the "Strict Criteria," the same criteria used by the Habers, were used, 3.3% of the 519 subjects were identified as eidetic children. By the "Less Strict Criteria," the percentage was 5.8%. The former percentage (3.3%) was significantly smaller than that found in the Habers' study (8%). Both these studies, however, revealed that eidetic imagery is not a widely prevalent phenomenon.

Travers' assumption was tested in four experiments. The rationale upon which these experiments were based was that because of a retarded erasure mechanism, images from antecedent stimuli continue to persist for a relatively long time and accumulate, overlap, or superimpose with the images, or even the percepts, of succeeding stimuli. Thirty eidetic children selected by the "Less Strict Criteria" and 30 non-eidetic children were used as subjects.

Results of these experiments can be stated as follows: (1) The mean reaction time to the offset of the visual stimulus for the eidetic children was significantly longer than that for the non-eidetic children. (2) In a task requiring the subjects to search out the absence of target stimuli, the mean search time was not significantly different for the groups established by the "Less Strict Criteria," but eidetic subjects selected by the "Strict Criteria" required significantly more time in this task than their counterparts. (3) The eidetic children demonstrated a persisting visual image in several ways. They reported a compound picture when two slide pictures were presented in sequence. They correctly identified figures that were "hidden" in sequentially presented dot-patterns. Also, they reported a stereoscopic effect when the left- and right-eye views were presented to the left and right eyes without the advantage of a stereoscope. Further, they reported the perception of an expanding spiral after viewing a rotating-contracting spiral while the stationary spiral had in fact been removed. (4) In EEG tests, the post-stimulation recovery time of the eidetic children was significantly longer than that for the non-eidetic children. The post-stimulation alpha index for the eidetic children was significantly smaller than that for the non-eidetic children.

While deductions based upon Travers' assumption were generally confirmed, there were several results that indicated that the construct of a deficient erasure mechanism was not sufficient to account for the phenomena associated with eidetic imagery. The limitations of Travers' assumption were discussed and a new model for the phenomena of eidetic imagery tentatively proposed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The image one experiences after he has observed an external object is usually less vivid and less clear than the _percept_ of that real object. Sometimes, however, one may experience images that are as detailed, clear, and vivid as the percept of a real object. Such imagery, named "visual eidetic imagery," is the concern of this paper.

An _eidetic image_ is defined by Haber and Haber (1964) as "a visual image persisting after stimulation, relatively accurate in detail, colored positively, and capable of being scanned" (p. 131). An eidetic (from the Greek _eidos_--that which is seen) image resembles an _after image_ in that it is in a literal and true sense "seen," the attention of the observer being directed outwards. It resembles a _memory image_ in that it also possesses 'associative' characteristics, its content being selective and controllable by an act of will. However, an eidetic image differs from an after image in that it is commonly seen without fixation, and seen in positive color. It differs from a memory image in that it is vividly detailed and is almost photographic in fidelity. Thus, while Jaensch (1930) said that an eidetic image occupies an intermediate position between the after image and the memory image (p. 2), Allport (1928) suggested that an eidetic image is essentially a variety of a memory image (p. 424). Morsh and Abbott (1945) asserted that it is essentially a variety of after image (Richardson, 1969, pp. 127-128).

Historical Review of Literature

The first empirical investigations of eidetic imagery were reported in 1907 by V. Urbantschitsch, who noted that although eidetic images were primarily a phenomenon of childhood, they tended to occur in more excitable children. In 1917, Otto Kroh, a teacher in a Marburg high school, reported that visual eidetic imagery was relatively common in normal school children. This event inaugurated the long series of investigations undertaken by the Jaensch brothers and their students at the Marburg Institute for Psychology (Richardson, 1969, pp. 29-30). Jaensch (1930) also asserted that eidetic images are only the most obvious symptoms of widely prevalent structures of the normal youthful personality. He found that these images can be divided into two types, whose structural characteristics can be traced throughout the whole psychophysical constitution. If a large number of young eidetic subjects is examined, two types clearly differentiate themselves among cases of approximately equal frequency: those who have eidetic images that are close to after images (AI-like eidetic images), and those whose eidetic image follow the law of memory images more closely (MI-like eidetic images). The AI-like eidetic images have only a slender connection with the rest of the mental life. Just as in after images, they are dependent to a high degree on the physiological conditions of sensory stimulation. The children who have these images can produce changes in the content, form, and color of the eidetic images only with difficulty. The images are felt as foreign bodies in the mental life, and something alien to the personality and sometimes as positive hindrances (pp. 26-27). On the other side, the MI-like eidetic images hardly depend on sense-physiological or optical factors at all, but most decisively on psychological factors. Like memory images, the colors of these eidetic images always correspond to those of the real objects; the forms and location are changeable. The children who have these images can call up their eidetic images and banish them at will. Therefore, the eidetic images are no longer regarded as something foreign, but as something belonging to the self; not as an annoyance, but as a _gift_ one wants to retain (pp. 26-30). As regards somatic characteristics, Jaensch also noticed that there is a distinct difference between these pure types. The eyes of the subject with AI-like eidetic images are small, deep-set, comparatively lifeless, without lustre, with no 'soulful' expression, and thus often remind one of an automaton or a machine. In very pronounced cases there may be present a peculiar, 'pinched' facial expression, which is known to medical men as the '_tetany_ face' (pp. 30-31). On the other hand the eyes of the subject with MI-like eidetic images are large, lively, and with 'soulful' expression, and thus present us with a true mirror of the continuously fluctuating inner world of youth. In pronounced cases, the eyes are large and protuberant, which is one of the most striking symptoms of Basedow's (or _Grave's_) disease (p. 32). To indicate the relation of these two types of clinical conditions (Tetany and Basedow's disease), Jaensch called the first, 'T-type'; the second, 'B-type'. In practice, only the pure B-type is found to be relatively frequent. The pure T-type is much rarer. The great majority of cases are an 'amalgam' of the B and T types. To Jaensch, these symptoms are merely normal physiological characteristics of a certain youthful stage of development, and in no way a pathological manifestation (pp. 33-39). In short, Jaensch's typological theory asserts that people fall into several distinctly different types, on the basis of the forms of eidetic imagery they experience. These differences in experiences were related to basic differences in styles of perceptual and cognitive functioning and thus to differences in over-all personality patterns (Krech, et al., 1969, p. 706).

Though Jaensch's theory is not confirmed by most experimental evidence, some of his inferences regarding the probable significance of eidetic imagery for aesthetics, education, epistemology, and psychology merit careful investigations (Allport, 1928, p. 425).

In the English-speaking world, there were also a few psychologists who studied the phenomenon of eidetic imagery during the past forty years. G. W. Allport (1924) also believed that eidetic imagery is commonly present in children. The function of the eidetic imagery seems to be to preserve and to elaborate a concrete stimulus situation for the child in such a way as to intensify for him the sensory aspects of experience. By so doing it enhances for him the meaning of the stimulus situation and enables him to repeat and to perfect his adaptive responses (pp. 117-120). However, Allport claimed that the Marburg theories are not acceptable, for they rely for support upon aspects of the eidetic phenomenon about which there is great uncertainty (p. 120). In 1928, he continued to criticize Jaensch's hypothesis which states that the eidetic image stands midway between the after image and the memory image, or that the after image, the eidetic image, and the memory image respectively form a continuum. He listed some substantial identities of both an eidetic image and a memory image and asserted that the eidetic image is only a special variety of memory images. He, however, did not deny the existence of eidetic images. He said that although the eidetic image is a member of the general class of memory images, it does possess features which distinguish it in degree. It is more complete, livelier, and more accurate (p. 424).

H. Klüver (1925, 1926, 1928, 1929, 1930, 1931, 1932) not only made many excellent introductions and reviews of the literature on eidetic imagery, but performed some empirical investigations. Using 27 eidetikers as subjects, he (1926) found that: (1) the deviation from Emmert's law is much more pronounced in the case of eidetic images than in the case of after images (p. 187); (2) the eidetic images of animal-pictures have a greater tendency to retain the original color than the eidetic images of squares or of uninteresting objects (p. 198); (3) it is possible to see a very complicated (silhouette) picture in the eidetic images after a relatively short exposure-time; and (4) most of the eidetikers see the candle, at least for a certain time, in three dimensions (p. 208). Klüver (1928), after having reviewed the literature on eidetic imagery, put special emphasis on two points: (1) it is possible to utilize objective methods, or laboratory methods, for the determination of the subjective experiences of the individual (p. 94), and (2) one of the most urgent problems in eidetic research is to clear up the striking geographic differences (p. 95). Later, Klüver (1933) found no racial differences in studying the eidetic imagery of Italian, Jewish, and Negro school children in the United States. These results were contrary to what Jaensch had expected (see Peck and Hodges, 1937, p. 143).

In a study by Meense (1933), 34 out of 100 negro school children were reported to be eidetic. Most of these subjects succeeded in synthesizing a figure consisting of two parts, one of which formed an eidetic image which was projected upon a background containing the other (pp. 688-689).

H. E. O'Neill (1933) found out that the eidetic image exists as an unusual rather than as a universal phenomenon of childhood (p. 74), also just contrary to what Jaensch had found. In addition, he claimed that in very young children the confusion between percept and image may become so great that the child indulges in those grotesque fabrications which are so inexplicable and so annoying to their elders. However, as the child grows older he becomes aware of the disparity which exists between imagery and reality, and he may react to this consciousness in one of three ways: (1) by tending toward extreme objectivity; (2) by accepting the situation reasonably; and (3) by seeking refuge in an imaginary world. And the most dangerous of these choices is the third one, especially for the eidetiker. By this way, he pointed out the importance of the eidetic ability to the welfare of the child who possesses it (pp. 71-74).

H. Teasdale (1934) was the first person who used a quantitative method to study the phenomenon of eidetic imagery. In reviewing previous investigations on eidetic imagery, he found out that much of the previous work had been confined to a study of isolated cases, that conclusions were drawn without sufficient statistical evidence to support them, and that different investigators used varying experimental conditions and used different criteria for determining the strength of the eidetic disposition (pp. 56-57). Using an objective marking system, he obtained results indicating that if only the richest and most stable images are counted as eidetic images then it can be shown that eidetic ability is most frequent at the youngest ages tested. But if the "pass standard" is made a little lower so that images of a rather inferior type are included then eidetic images are found to be most frequent from 11-12 years. Therefore, according to Teasdale, there are two types of eidetic images, one which is very prevalent among young children and decreases with increasing age, and one which is not so rich in detail, which does not show such marked divergencies from normal after images and which becomes more frequent with increasing age up to 14 years (pp. 71-72).

The first study using preschool children as subjects to investigate eidetic imagery can be found in L. Peck and R. Walling's report (1935). Peck and Walling examined 20 nursery school children, ranging in age from 24 to 60 months, and found that 50% of them were eidetikers (p. 179). L. Peck and A. B. Hodges (1937) investigated the incidence of eidetic ability in 208 white, 50 Mexican, and 50 Negro children from three to six years of age. The results indicated the existence of racial differences in the eidetic ability of preschool children. The Negro group not only led in percentage of eidetic images, but also led the other groups in richness of detail and duration of images. The Mexican children possessed a slightly higher eidetic ability than the white children (p. 141 & p. 159).

In the years after 1937, sporadic interest continued, but only two papers of theoretical interest appeared in the journals--one by Morsh and Abbott (1947) asserting that the eidetic image is merely a vivid after image, probably due to persistence of activity in the retina; and the other by Traxel (1962), concluding that eidetic imagery is a combination of efficient retention, vivid memory images and suggestion

(Richardson, 1969, p. 30). As R. N. Haber and R. B. Haber (1964) have pointed out, the reasons for so sharp a change probably included (1) the lack of a sound theoretical base, (2) the behavioristic climate against this introspective subject, and (3) the strangeness and unusualness of the behavior, at least as viewed by adult psychologists (p. 132). Thus, the research work for eidetic imagery was almost discontinued.

Soon after the advent of the computer and the development of information sciences, the cognitive psychology which deals with sensation, perception, imagery, retention, recall, problem-solving, and thinking once again began to play an important role. In 1964, after 20 years of neglect of research on eidetic imagery, the publication of Haber and Haber's paper began to attract psychologists' attention. In the study by Haber and Haber (1964), the complete data were obtained from 151 boys and girls, 8 to 12 years of age, from an elementary school in New Haven, Connecticut. Care was taken to specify and follow precise methods for measurement, and strict criteria were used for the discrimination of eidetic images from after images and from memory images. The results indicated that (1) only 8% of the subjects were eidetikers, (2) the distributions of scores of eidetic imagery were discontinuous rather than continuous, and (3) contrary to expectation, the memory of the eidetikers for the stimulus pictures, after the eidetic imagery had faded, was not strikingly better than that of the non-eidetikers. Apparently, the eidetikers were not using the time during which the image was present to encode the stimulus for later recall (pp. 137-138).

Since Haber and Haber had found that eidetic imagery is not a common phenomenon among normal American children, Siipola and Hayden

(1965) started to assume that eidetic imagery might be an abnormal phenomenon, more likely to be found among retarded children. It was further reasoned that the prolonged retention of a primitive form of cognition (typified by eidetic imagery) would be a more likely component of a generally retarded rate of conceptual and language development. This hypothesis was tested by using 34 retarded children as subjects. Result indicated that the difference in the proportion of eidetikers in the retarded group and in Habers' normal group was highly significant (26.5% vs. 8%). Thus the hypothesis was positively supported (pp. 275-281). In the same study, Siipola and Hayden also found that the frequency of eidetikers in brain-injured mental detardates was significantly greater than that of familial mental retardates (50% vs. 5.6%). The authors concluded that possibly eidetic imagery is related to damage in a specific area of the brain (pp. 280-282).

More recently Freides and Hayden (1966) have reported three cases in which eideticism occurred in one eye only. Their preliminary findings suggest that this unilateral eidetic imagery is related to brain damage in the contralateral hemisphere (Richardson, 1969, pp. 32-33).

Some cross-cultural studies have also appeared. Using the Habers' (1964) criteria, L. Doob (1964, 1965) investigated eidetic imagery among the members of two non-literate societies in Africa. A total of 20% were found to be eidetic among the Ibo samples (p. 360), and a total of 13%, among the Kamba samples. The incidence of eidetic imagery was much higher than that normally found in the West. In subsequent investigations in other African societies, however, Doob (1966) reported only a total of 4% among the Masai, 0% among the Somali, and 7% among the Swahili (Richardson, 1969, p. 37).

In 1969, R. N. Haber reiterated the claim that the phenomenon of eidetic imagery really does exist. His results were based on about 20 eidetikers who had been screened from more than 500 children (p. 36). After having undertaken many kinds of experiment, Haber listed some evidence to support the argument that eidetic images are visual in nature and not dependent on memory in any way: (1) An eidetic child can remember parts of the picture he cannot see in his image, and he says he did not have an image of those parts because he did not look at them long enough; (2) a conscious attempt to label the content of the stimulus interferes with the formation of an image; (3) nearly all the eidetic children report the same pattern of fading in their images, even though that is only one of a number of possible sequences; (4) when asked to move their image from one surface to another, eidetic children report spontaneously that when it reaches the edge it falls off; (5) when the child forms an image of letters exposed individually in a window, he moves his image to the left as a new letter appears in the window; (6) children are most capable of seeing details that they scanned most recently, a result contrary to normal organization in memory; (7) at least some of the eidetic children are able to develop three-dimensional images (pp. 43-44). Haber also tried to develop a test for the screening of eidetic imagery that did not depend on verbal facility and could not be biased by memory. One of the tests he designed, called the Recognition Test, was designed in such a way that if a first picture is superimposed on a second picture, a third picture (a face) is formed by the combination. It was found out that four of his eidetic children were able to form a combination picture by visually superimposing an image of a picture on another picture (p. 44). Haber's experiments are very enlightening and cogent from a methodological point of view.

Recently, some even more creative and constructive techniques for the screening of eidetic subjects were developed by C. F. Stromeyer III (1970). Stromeyer (1970) insisted that the test used by Haber (1969) cannot distinguish between superior memory and a projected eidetic image. For instance, in Haber's Recognition Test, or composite picture, too often a subject can look at the component drawings and guess the composite picture. Because of this, the reality of eidetic imagery has been questioned (p. 77). To distinguish superior memory from eidetic imagery, Stromeyer developed some ingenious techniques. In one experiment, for example, the subject was first asked to view with her right eye a computer-generated 10,000-dot pattern for one minute, and after ten-second rest, to look at another 10,000-dot pattern with her left eye. She was then asked to superimpose the eidetic image of the right-eye pattern on the actual left-eye pattern. Without hesitation the subject reported that she saw the letter T coming toward her. The eidetic subject accomplished this without using a stereoscope. After using some other techniques like this (see pp. 77-80), Stromeyer concluded that eidetic imagery does exist (p. 77). The development of Stromeyer's techniques began a new epoch in the history of the research on eidetic imagery.

The Purposes of the Present Study

From the literature reviewed above we know that (1) the studies on eidetic imagery have mainly been undertaken in Germany and in the United States, and (2) most of the studies have focused upon the description of eidetic imagery. The study of the effect of eidetic imagery on the behavior of the eidetikers is rare or absent.

Therefore, the purposes of the present study are:

1. To investigate the prevalence of eidetic imagery among the elementary school children in Taipei, Taiwan.
2. To compare the effects of eidetic imagery on some behavioral indices, such as (1) reaction time, (2) search time, (3) frequency of composite and superimposed images, and (4) recovery time of alpha rhythm of EEG, between eidetikers and non-eidetikers.

For the first purpose, an inferential study of the percentage of eidetic children will be made (Chapter II). For the second purpose, four experiments will be undertaken and the effects of eidetic imagery upon the behaviors of eidetic children will be explored (Chapter III).

CHAPTER II

AN INFERENTIAL STUDY OF THE PERCENTAGE OF THE EIDETIC CHILDREN

It is important for us to know the percentage of the eidetic children. If the percentage of eidetic children is found to be as high as 3% or 5%, it could be very significant in education, since enormous numbers of children would be affected.

In previous studies, quite inconsistent results were obtained by different investigators of eidetic imagery. The findings may be classified into three categories. (1) *Studies in which the phenomenon of eidetic imagery was found to be common, universal, or prevalent*: Jaensch (1930) found that eidetic images are only the most obvious symptoms of widely prevalent structures of the normal youthful personality. Allport (1924) also believed that eidetic imagery is a common characteristic of children. Meense (1933) reported that 34 of 100 negro school children were eidetic. Peck and Walling (1935) examined 20 nursery children, ranging in age from 24 to 60 months, and found that 50% of them were eidetikers. Siipola and Hayden (1965) found that 50% of his brain-injured subject were eidetic. (2) *Studies in which the phenomenon of eidetic imagery was found to be unusual, rare, and infrequent*: O'Neill (1933) reported that the eidetic image exists as an unusual rather than as a universal phenomenon of childhood. Haber and Haber (1964) said that, contrary to a voluminous literature, the prevalence of eidetic imagery was quite low--about 8%. (3) *Studies in which the percentage of eidetikers was found varying*: Klüver (1931) pointed out that the incidence of eidetic ability in non-adult population had been estimated all the way from 0% to 100% (p. 656). Teasdale's

(1934) result indicated that if a strict standard was used, then only 5.8% of boys between the ages of 12 and 13 were eidetics. However, if the standard was lower, then 21% of these boys were eidetics (p. 66).

Some inconsistent results were also obtained from the studies on racial differences in eidetic disposition. Klüver (1931) found no racial differences in studying the eidetic imagery of Italian, Jewish, and Negro school children in the United States. However, Peck and Hodges (1937) reported that there existed racial differences among white, Mexican, and Negro school children. Doob's (1964, 1965) investigation also showed that the prevalence of eidetic imagery in the non-literate African samples, Ibo and Kamba, was much higher than that normally found in the West.

As Teasdale (1934) had pointed out, these inconsistent results may have resulted from different investigators using varying experimental conditions, and different criteria for determining the strength of the eidetic disposition. However, in addition to these, it seems that so far no study on eidetic imagery has ever relied upon a random sampling method in selecting the subjects. The percentage is meaningless and not representative unless random sampling is used.

Then, if a random sampling method is used, and conditions and criteria similar to those used by Haber and Haber (1964) are adopted, (1) what will the percentage of eidetikers be among the Chinese school children in Taipei City? (2) is there a difference in the percentage of eidetikers between Chinese school children and American school children, as produced by Haber and Haber's (1964) study? Now, the first substansive hypothesis for the present study is as follows:

Hypothesis 1: There is difference between Chinese and American school children in regard to the prevalence of eidetic imagery.

METHOD

In this study, a construct replication, rather than a literal replication, was used to repeat Haber and Haber's (1964) experiment (see Lykken, 1968, pp. 155-156). On the whole, the method used here was about the same as the Habers' method, except that the sampling procedure, the content of the stimulus pictures, and the testing methods for memory were different.

1. Subjects

The population from which the sample was drawn was the 130,000 elementary school children, Grade 3 to Grade 6, in Taipei City, Taiwan. (Younger children were not used as subjects because of the difficulty of obtaining reliable oral reports.) A table of the public elementary schools in Taipei City, published by the Bureau of Education in September, 1970, was prepared. First, 11 schools were randomly drawn from the 57 public elementary schools listed in the table. Then, 524 students in Grade 3 to Grade 6 were drawn from these 11 schools by using complete random sampling. Table 1 shows the frequencies of distribution in terms of the subjects' age and sex.

Table 1. The Distributions of Age and Sex of the Subjects

Age	8	9	10	11	12	13	Total
Month	96-101	102-113	114-125	126-137	138-149	150-159	
Boys	6	71	71	79	61	4	292
Girls	6	58	49	57	60	2	232
Total	12	129	120	136	121	6	524

2. Materials and Procedures

Since the early days of the Marburg investigations it has been common practice to prepare subjects for their eidetic imagery test by first presenting a test of after imagery. In this way, (A) the subject obtains a preliminary experience of one kind of "seen" imagery. Otherwise, he might not understand what it means to see something, although no object is actually present. (B) The experimenter may pay special attention to those whose after-images are not in the complementary, but in the original colour, as this points to a relatively high degree of eidetic disposition (Jaensch, 1930, pp. 4-6).

(1) Tests for After Images

The subjects were individually brought into a room which contained a table with an easel on it. The easel (76 cm. high and 60 cm. wide, in neutral-gray color) was tilted away from the subject slightly and had a narrow ledge along the bottom on which a display-board was rested. (The display board is 45 cm. x 50 cm., with a handle on right side and a small magnet attached on the center. It is also in neutral gray.) The subject was seated 50 cm. away from the easel, his eyes level with the middle of it. The background of the easel was illuminated by daylight which came indirectly from the left side of the subject. The sunlight was never allowed to fall on the background. A tape recorder was used to transcribe both the subject's and the experimenter's voice.

Five 10 cm. x 10 cm. colored squares (green, red, blue, black, and yellow, always in this order) were used as materials. The green square was used as an example to demonstrate to the subject what was meant by seeing something. The other four colored squares were exactly the same as those used by Haber and Haber. Attached on the back of each colored square was a small piece of iron. To present the colored square, the experimenter mounted the square on the display-board by attaching the piece of iron on the small magnet, and then he rested the display-board on the ledge of the easel. To remove the colored square, he took away the display-board by a handle.

The child was checked by using a color plate with 12 color samples on it so that the experimenter might know whether the subject was familiar with the names of colors. Then he was first shown the green square. He was instructed to stare at the center of the green square as hard as he could. After 10 sec., when the green square was removed, he reported what he still saw on the easel.

The following instructions were given to the subject at the beginning.

"I am going to show you some colored squares. When I present each color square, I want you to stare at the center of it as hard as you can, and try not to move your eyes as long as it is still there. When it is removed, I want you to continue to stare as hard as you can where the square was. If you stare hard enough, you will still be able to see something there. And if you see anything, I want you to tell me right away what you still see there. OK, here is the first colored square."

The other four colored squares, red, blue, black, and yellow, were respectively presented in a similar fashion. The exposure time was also 10 sec. each.

During the exposure time, the experimenter had to watch carefully to be sure the subject did not move his eyes. When the subject was reporting, the experimenter measured the time from the appearance of the after image to the disappearance of it, and also wrote down the subject's responses on a data sheet prepared beforehand. (See Appendix A.) Special attention was paid to those whose after images were not in complementary color and those whose durations were extraordinarily long.

(2) Tests for Eidetic Images

When the tests for after images were over, the experimenter continued with the following instructions:

"Now, I am going to show you some other pictures. For these, however, I do not want you to stare in one place, but to move your eyes around so that you can see all parts of them. When the picture is moved away, I want you to continue to look around at the easel where the picture was, and tell me what you can still see after I take it away. OK, here is the first picture."

The same easel and the same display-board were used to expose the pictures. The exposure time was 30 sec. each, exactly the same as that of the Habers' study. After the experimenter demonstrated the procedure by using one picture as an example, the following five pictures were presented respectively (see Figure 1).

Picture 1, Silhouette: Black and White, 20 cm. x 16 cm., of a street scene in which there are a man pushing the car, a woman with an umbrella, a church, trees, houses, dogs, men, lamp posts, etc. (from Klüver, 1926).

Picture 2, Miscellanea: Colored, 16 cm. x 18 cm., consisting of 12 small single pictures, namely, a vegetable, a lion, three bottles, a flower, a lamp, an apple, a postman, a watch, two bowls, a house, a monkey, and a duck. Each small picture has a different color as its background (cut out from Ying and Hang, 1970).

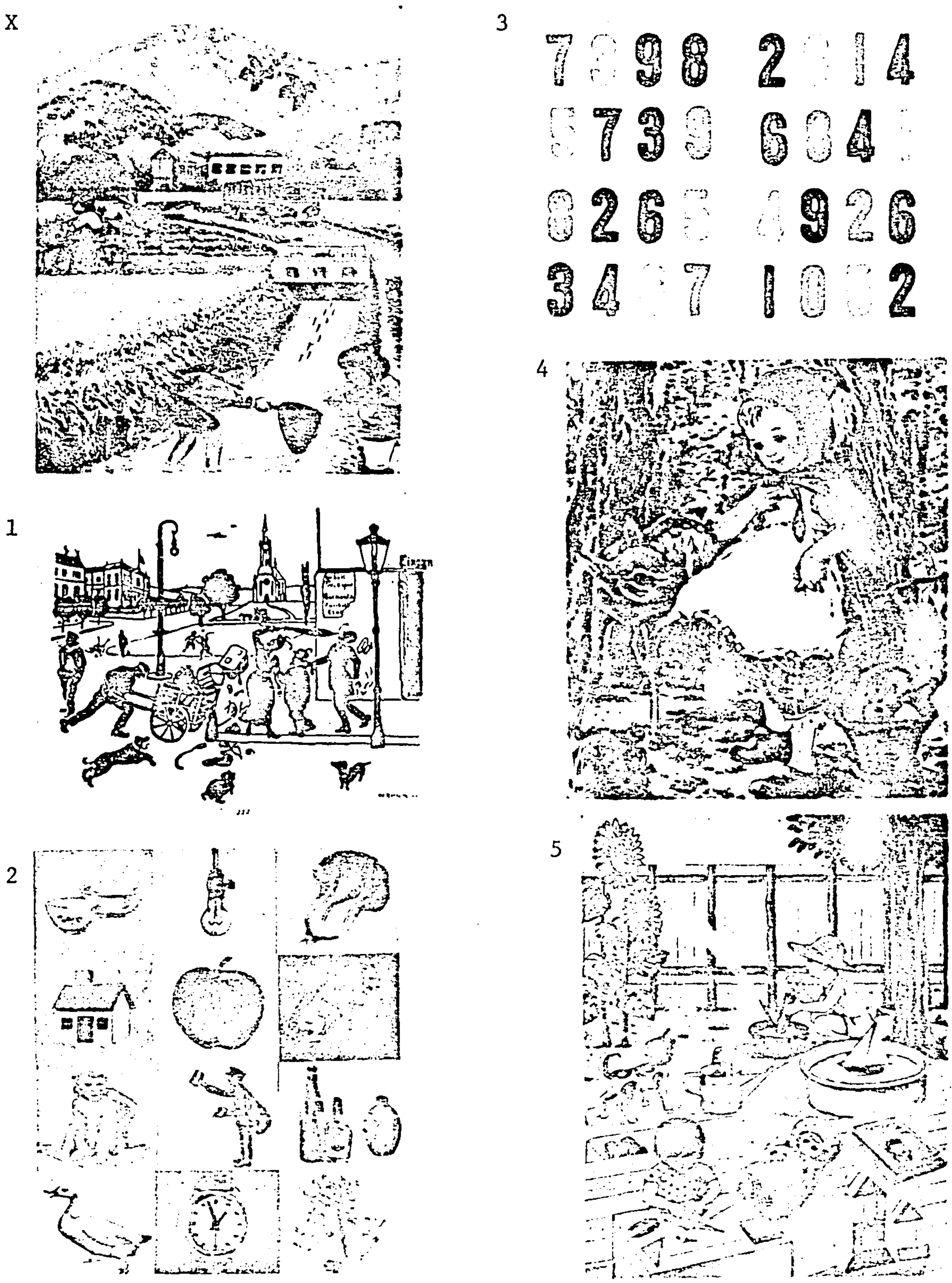


Figure 1. The Stimulus Pictures Used in Tests for Eidetic Images. X, Example Picture; 1, Silhouette; 2, Miscellanea; 3, Numeral; 4, Kerchief; 5, Gardening. (Sources, see text.)

Picture 3, Numeral: Colored, 19 cm. x 15 cm., of 32 random Arabic numerals, arranged in 4 rows and 8 columns; randomly colored with red, blue, green, and yellow (self-made).

Picture 4, Kerchief: Colored, 16 cm. x 19 cm., of a forest scene, in which there are a little girl with a red kerchief, blue apron, and a pair of big, red shoes; a deer, a squirrel, a bird, trees, and a basket with fruits and a bottle (from Little Red Hat, Taipei: Prince Printing Co., n.d.).

Picture 5, Gardening: Colored, 16 cm. x 19 cm., of a garden scene, in which a boy with a yellow hat and a blue shirt is watering flowers, a girl is playing with some colored papers, a basin with a boat, a doll, a book, a dog, a tree, a fence, a watering pot, and some blocks (modified from Chen, 1971).

All pictures were presented for 30 sec. each. The experimenter watched carefully during the exposure time to be sure the pictures were scanned and not fixated. If the subject reported seeing an image of some kind after the picture was removed, the experimenter (1) asked if he was actually seeing it or remembering it from when the picture was still on the easel, (2) asked whether it was located "out there" (pointing to the easel) or "up there" (pointing to the subject's head), (3) frequently asked if he was still seeing it, so as to make sure that the subject did not continue reporting when the image had faded, and (4) noted the relation between direction of gaze and the details of report to see whether the subject move his eyes spontaneously. At the same time, the experimenter wrote down the subject's responses, including the details, the colors, and the duration of the images. (See Haber and Haber, 1964, pp. 134-135; Siipola and Hayden, 1965, p. 278.)

(3) Tests for Memory

Soon after the subject reported the entire image for Picture 5 (Gardening) had faded, he was tested for his memory of Picture 5 with regard to the details and the colors. No subject knew that he would be tested for memory before this section. In this study, instead of using a recall method as the Habers had done, the experimenter used the recognition method to test the memory of details, and the redintegration method to test the memory of colors.

A. Details

A set of 20 cards, each 9 cm. x 7 cm., was used to test the subject's recognition of the details of Picture 5. On each card there was a single-picture in black and white. Of the 20 cards, there were 10 cards with which the subject then became familiar, since the single-pictures on these cards were from Picture 5, which he had just seen. These 10 cards were then mixed randomly with additional 10 cards of the same general kind which he was unfamiliar (also from Chen, 1971). The subject was asked to sort out those he had seen in Picture 5, that is, to sort the original pictures in the 'familiar' pile, and the new or misleading ones in the 'unfamiliar' pile. The experimenter recorded the subject's responses on the data sheet.

B. Colors

A Xeroxed copy of Picture 5, now in black and white, was presented to the subject first. He was then asked to recollect the original colors of the 10 representative details which had been selected by the experimenter beforehand. The subject was allowed to answer the question by seeing and pointing to the plate of color samples, which had been used before the test for after images. The experimenter recorded the answers of the subject.

(4) Test for Intelligence

J. C. Raven's Progressive Matrices Test, as restandardized by the Department of Educational Psychology, National Taiwan Normal University, was administered to the subjects by groups. The raw scores thus obtained, along with the subject's chronological age, were converted into percentile ranks by comparing them with the percentile norm. Thus, in the present study, "intelligence" was operationally defined as "that which J. C. Raven's Progressive Matrices Test measures."

3. Scoring

The data sheet was first checked and complemented by listening to the tape recorder. Then, the data were subjected to scoring by two independent judges using an independent scoring method. The scoring system for eidetic imagery was the same as that of Haber and Haber (1964). The scoring system for memory, however, was not the same.

(1) Scoring for Eidetic Images

A. Details

The accuracy of the details of the images for the pictures was rated on a 9-point scale. The two judges obtained agreement, before they started to rate, that 1 was to be rated whenever no image was reported, or no positive image was reported, and 9, on the other end of the scale, was to be rated if the images reported were very accurate and detailed.

B. Colors

The accuracy of the coloring of images for the pictures was rated on a 5-point scale. The two judges also agreed that 1 was to represent that no image was reported, only the negative image was reported, or the colors reported were all inaccurate, and 5, to represent that the colors reported were almost accurate or very accurate.

C. Duration

The duration was measured in seconds, which was obtained directly from the subject's oral report and was checked again by listening to the tape recorder. Only one judge was used for this.

(2) Scoring for the Memory of Picture 5

A. Details

A recognition score was obtained by using the following formula (Woodworth and Schlosberg, 1958, p. 700):

$$\text{Recognition score} = \frac{\text{Right-Wrong}}{\text{Total}} \times 100$$

Where "Total" = 20, that is, 10 original pictures plus 10 new pictures. "Right" = the Yes responses to the original pictures plus the No responses to the new pictures. "Wrong" = the No responses to original pictures plus the Yes responses to the new pictures. Thus, if all the original pictures were sorted in the "familiar" pile and all the new ones in the "unfamiliar" pile, the subject got a score of 100.

B. Colors

One mark was given for each correct redintegration of the color of each detail. Since the original colors of 10 representative details were asked, the maximum number of marks for each subject was 10.

4. The establishment of the Eidetic and Non-Eidetic Groups by the "Less Strict Criteria"

The records of 5 of the 524 subjects drawn to participate in the test for eidetic imagery were discarded due to language or visual difficulties. Of the remaining 519 subjects, 272 reported images of at least one of the pictures. The 30 most extreme subjects in this group were discontinuous from the remaining 242 subjects on the scores for details, colors, and duration. These 30 subjects met the following criteria, called the "Less Strict Criteria," and therefore were selected to serve as an Eidetic Group, the experimental group, in the present study.

(1) Positive images were reported in all 5 stimulus pictures.

(2) The accuracy of the details of each image was rated 5 or greater.

(3) The accuracy of the coloring for each image was rated 3 or greater.

(4) The image lasted over 30 sec.

Of the 519 subjects whose data were available, 247 reported seeing no images at all. From these imageless subjects, 30 were selected to serve as the Non-Eidetic Group, the control group, for the present study. They were individually matched with the members of the Eidetic Group on the bases of sex, age, and intelligence (see Table 2). Since the variables related to the phenomenon of eidetic imagery are still unknown, the Eidetic Group and the Non-Eidetic Group are still not considered as equivalent, especially so far as eidetic imagery is concerned (see Underwood, 1966, pp. 124-125).

Table 2. The Mean IQ's and the Mean Raw Scores of the Intelligence Test for the Two Groups

	Age (in month)		Raw Scores of Intelligence Tests	
	M	SD	M	SD
Eidetic Group	128.6	14.5	38.9	8.9
Non-eidetic Group	129.8	13.2	37.6	8.6
	t = .34	n.s.	t = .61	n.s.

5. <u>Reliabilities</u>

(1) <u>Scoring Reliabilities</u>

The responses made by each subject in the test for eidetic imagery were rated by two independent judges. Table 3 shows the reliabilities of the scoring made by these two judges. No matter whether continuous ratings or dichotomous ratings were used, all the scoring

Table 3. The Reliabilities of Scoring on the Details and the Colors of Images

Rating Methods	Number of Subjects	Details	Colors
Continuous Ratings	Eidetics & Non-eidetics, N=60	r=.99	r=.98
	Eidetics Only, N=30	r=.86	r=.75
Dichotomous Ratings	Eidetics & Non-eidetics, N=60	C=.59	C=.68*

*The upper limit of the contingency coefficient for a 2 x 2 table is .707.

reliabilities were very significantly different from zero.

(2) Test-retest Reliabilities

Two months after they had taken the test for eidetic imagery, all the subjects in both the Eidetic and Non-Eidetic Groups were retested, using the same procedures and the same pictures. The test-retest reliabilities thus obtained are shown in Table 4. The reliabilities on all measures were also significantly different from zero.

Table 4. Test-retest Reliabilities of the Measures on the Details, Colors, and Duration of Images

Rating Methods	Number of Subjects	Details	Colors	Duration
Continuous Ratings	Eidetics & Non-eidetics, N=60	r=.91	r=.89	r=.63
	Eidetics Only, N=30	r=.74	r=.62	r=.38*
Dichotomous Ratings	Eidetics & Non-eidetics, N=60	C=.62	C=.61	C=.63**

*p < .05
**The upper limit = .707

RESULTS

1. The Estimate and the Inference of the Percentage of the Eidetic Children

(1) By using Haber and Haber's (1964) criteria--the "Strict Criteria."

Haber and Haber (1964) reported that all images of their eidetikers lasted over 40 sec. and that all of the images had an accuracy of 6 or greater (p. 136). The following criteria, called the "Strict Criteria," were adopted to select the subjects with "strong" eidetic disposition. One may say that these criteria were just the same as those of the Habers'.

(1) Positive images were reported in all stimulus pictures excepting Picture 3 (Numerals).

(2) The accuracy of the details of each image was rated 6 or greater.

(3) The accuracy of the coloring for each image was rated 4 or 5.

(4) The image lasted over 40 sec.

Of the 519 subjects in the present study, 17 met these criteria. Thus, if the Strict Criteria were used, the percentage of the eidetic children in the present study was 3.3%. Haber and Haber (1964) found that 12 (8%) of his 151 subjects were eidetikers. The percentage of the eidetic children in the present study was significantly different from that in Haber and Haber's study, $t = 2.50$, $p < .05$. (Formula from McNemar, 1966, p. 60.)

(2) By Using the "Less Strict Criteria"

The Eidetic and Non-Eidetic Groups were also established by using the "Less Strict Criteria." By this criteria, 30 (5.8%) of the 519 subjects had been classified as eidetikers.

2. Eidetic Imagery and Sex, Age, and Intelligence

(1) Distribution of Eidetic Imagery by Sex and Age

Table 5 shows the distributions of sex and age of the Eidetic Group. Also presented together with these observed frequencies are the distributions of sex and age of the 524 subjects sampled, and the expected frequencies derived from the total sample distributions. The discrepancies between observed and expected frequencies were tested by using the χ^2 one sample test (Siegel, 1956, pp. 42-47). With regard to "age," the discrepancy between observed and expected frequencies was not significant, $\chi^2 = 3.29$, df = 3, $p > .50$. As regards "sex," the discrepancy between observed and expected frequencies was also not significant, $\chi^2 = 2.17$, df = 1, $p > .10$.

Table 5. The Observed and Expected Frequencies of Sex and Age of the Eidetic Group

Age (in months)	Observed Freq. in Eidetic Group				Observed Freq. in Total Sample	Expected Freq. in Eidetic Group	
	Boys	Girls	Total				
150-156	0	1	1	11	6	0	7
138-150	5	5	10		121	7	
126-137	3	3	6		136	8	
114-125	4	3	7		120	7	
102-113	1	4	5	6	129	7	8
96-101	0	1	1		12	1	
Observed Freq. in Eidetic Group	13	17	30		524	30	
Observed Freq. in Total Sample	292	232	524				
Expected Freq. in Eidetic Group	17	13	30				

(2) Eidetic Imagery and Intelligence

Of the 524 subjects sampled, there were only 480 subjects whose scores of intelligence test were available. Table 6 shows the distribution of intelligence for the Eidetic Group in terms of percentile ranks. Also presented is the distribution of intelligence for the 480 subjects, and the expected frequency derived from the total sample distribution. Dichotomizing both sets of frequencies, observed and expected, we obtained no significant discrepancy between these two sets of frequencies, $\chi^2 = 0.13$, df = 1, $p > .70$.

Table 6. The Observed and Expected Frequencies of Intelligence for Eidetic Group

Percentile Rank	Observed Freq. in Eidetic Group		Observed Freq. in Total Sample	Expected Freq. in Eidetic Group	
90-100	2		11	1	
80-89	4		68	4	
70-79	4	16	65	4	15
60-69	4		51	3	
50-59	2		43	3	
40-49	5		38	2	
30-39	3		43	3	
20-29	3	14	35	2	15
10-19	2		47	3	
0-9	1		79	5	
	30		480	30	

3. Stimulus Pictures and Details, Colors, and Duration of Eidetic Imagery

Tables 7 to 10 show to what extent the nature of the stimulus pictures affect the responses by subjects.

(1) Stimulus Pictures and Details of Eidetic Imagery

Every subject in the Eidetic Group had two scores, given by the two judges, indicating the accuracy of details for the eidetic image of each stimulus picture. By averaging the two scores for each stimulus picture, we obtained five mean scores for each subject in the Eidetic Group--one mean score for each of the five stimulus pictures. The data thus obtained were analyzed in Table 7 by an analysis of variance for repeated measures. Clearly, the results indicate that the ranked scores for details of eidetic images among five pictures were very significantly different, $F = 7.39$, $p < .01$. Tests on differences between pairs of means, as tested by the Newman-Keuls method (Winer, 1962, p. 114), are shown in Table 8. Picture 3 (Numeral), appeared to be significantly less effective than the other four pictures, namely, Silhouette, Miscellanea, Gardening, and Kerchief, in eliciting more accurate details of eidetic image.

Table 7. The Analysis of Variance for the Scores of Details of Eidetic Images Among Five Pictures

Source of Variation	SS	df	MS	F
Between Subjects	278.84	29		
Within Subjects	295.20	120		
Pictures	60.03	4	15.01	7.39**
Residual	235.17	116	2.03	
Total	574.04	149		

$^{**}F_{.99(4,116)} = 3.48$

Table 8. The Newman-Keuls Test on the Mean Scores of Details of Eidetic Images Among Five Pictures

Pictures		Numeral	Silhouette	Miscellanea	Gardening	Kerchief
	means	5.50	6.58	6.60	6.80	7.47
Numeral	5.50	--	1.08*	1.10*	1.30*	1.97*
Silhouette	6.58		--	.02	.22	.89
Miscellanea	6.60			--	.20	.87
Gardening	6.80				--	.67
Kerchief	7.47					--
$q_{.95}(r,116)$			2.80	3.36	3.69	3.92
$q_{.95}(r,116)\sqrt{\frac{MS_{res}}{N}}$			.728	.874	.959	1.019

(2) Stimulus Pictures and the Colors of Eidetic Images.

The effects of the differences among stimulus pictures on the colors of eidetic images also may be seen in Table 9. The results indicate that there were significant differences among pictures, $F = 3.46$, $p < .05$. Tests of differences between pairs of means, as shown in Table 10, also yielded significant differences between Picture 3 (Numeral) and the other four pictures.

Table 9. The Analysis of Variance on the Scores of Colors of Eidetic Images Among Five Pictures

Source of Variation	SS	df	MS	F
Between Subjects	72.315	29		
Within Subjects	91.900	120		
Pictures	9.790	4	2.448	3.46**
Residuals	82.110	116	.708	
Total	164.215	149		

$**F_{.99}(4,116) = 3.48$

Table 10. The Newman-Keuls Test on the Mean Scores of Colors of Eidetic Images Among Five Pictures

Pictures		Numeral	Silhouette	Miscellanea	Gardening	Kerchief
	Means	3.867	4.417	4.500	4.517	4.550
Numeral	3.867	--	.550*	.633*	.650*	.683*
Silhouette	4.417		--	.083	.100	.133
Miscellanea	4.500			--	.017	.050
Gardening	4.517				--	.033
Kerchief	4.550					--
$q_{.95}(r,116) \cdot \sqrt{\frac{MS_{res}}{N}}$		.430	.516	.567	.602	

(3) Stimulus Pictures and the Duration of Eidetic Images

In order that we may understand which stimulus picture tends to elicit longer eidetic-images, the data were also analyzed as shown in Table 11 and Table 12. Table 11 indicates that the experimental data obtained do not support the null hypothesis. Inspection of the mean duration of eidetic images for the

Table 11. The Analysis of Variance on the Duration (sec.) of Eidetic Images Among Five Pictures

Source of Variation	SS	df	MS	F
Between Subjects	154980.64	29		
Within Subjects	181528.00	120		
Pictures	17122.57	4	4280.64	3.02*
Residuals	164405.43	116	1417.29	
Total	336508.64	149		

$^{*}F_{.95}(4,116) = 2.45$

pictures in Table 12 shows that the duration of eidetic image for Picture 4 (Kerchief) was significantly longer than that of Picture 3 (Numeral).

Table 12. The Newman-Keuls Test on the Mean Duration (sec.) of Eidetic Images Among Five Pictures

Pictures		Numeral	Silhouette	Miscellanea	Gardening	Kerchief
	Means	56.43	59.60	69.13	79.57	83.67
Numeral	56.43	--	3.17	12.70	23.14	27.24*
Silhouette	59.60		--	9.53	19.97	24.07
Miscellanea	69.13			--	10.44	14.54
Gardening	79.57				--	4.10
Kerchief	83.67					--
$q_{.95}(r,116)\cdot\sqrt{\frac{MS_{res}}{N}}$		19.24	23.09	25.36	26.94	

4. <u>The Differences in Memory Scores Between the Eidetic Group and the Non-Eidetic Group</u>

Table 13 indicates the differences of memory scores for the details and the colors of Picture 5 (Gardening) between the Eidetic and

Non-Eidetic Groups. The scores for the memory of details were obtained by using the formula for recognition experiment. The maximum score is 100. The scores for the memory of colors were obtained by counting the number of right answers for redintegration. The maximum score is 100. We know from Table 13 that the Eidetic Group was significantly superior to the Non-Eidetic Group in the measures of detail memory and in the measures of color memory.

Table 13. Differences of Memory Scores Between the Eidetic and Non-Eidetic Groups

	Details		Colors	
	M	SD	M	SD
Eidetic group	70.67	18.37	4.00	1.80
Non-eidetic group	51.67	22.90	2.20	1.56
	$t = 3.55$, $p < .001$		$t = 4.14$, $p < .001$	

DISCUSSION

1. A Comparison with Haber and Haber's (1964) Study

The results we obtained showed that if the "Strict Criteria" were adopted, that is, if the same strict criteria used by the Habers were adopted, only 17, or 3.3%, of the 519 subjects in the present study might be classified as eidetikers. However in Haber and Haber's study, 12, or 8%, of their 151 subjects were identified as eidetic children. The difference between the two proportions was highly significant, $t = 2.50$, $p < .01$, with the percentage found by the Habers much higher. Thus, Hypothesis 1 of the present study, "There is difference between Chinese and American school children in regard to the prevalence of eidetic imagery," was supported by the experimental evidence. However, no decisive conclusion can be drawn here. At least three differences between the two studies are worthy of our special attention:

(1) Difference in the Sampling Procedure:

The subjects in the Habers' study were students in an elementary school of New Haven, Connecticut. The school had 245 children registered, of whom 179 were tested. Of the 179 subjects tested, only 151 were left in the sample (Haber and Haber, 1964, p. 133). It is clear that these subjects were not randomly drawn. A sample not drawn by a random sampling method would lose its representativeness or generalizability. The subjects in the present study, however, were randomly drawn as described earlier. It is likely that a randomly drawn sample will be more representative of the population from which it was drawn.

(2) A Slight Difference in the Subjects' Age:

The subjects in the Habers' study were 8 to 12 years of age. However, the distribution of their ages were not reported. The ages of the subjects in the present study were from 8 to 13, as reported in Table 1. Since there were only 6 subjects in the 13-year-old group, one may say that the subjects in the present study were also 8 to 12 of ages. Nevertheless, since there were only 12 subjects in the 8-year-old group, the proportion of the younger subjects in the present study was possibly lower than that of the Habers' study.

(3) Differences in the Nature of Stimulus Pictures:

In general, the stimulus pictures used in the present study were more complicated and more unorganized than those used in the Habers' study. Of the five stimulus pictures used in the present study, there was only Picture 4 (Kerchief) that was comparatively similar in complexity to the stimulus picture "Alice in Wonderland" (Haber and Haber, 1964, p. 134; Haber, 1969, p. 37). Of the remaining four pictures, Picture 1 (Silhouette) and Picture 5 (Gardening) were rather complicated and very detailed. They were selected in the hopes that no subject would memorize all of them within 30 sec., the exposure time, even if he had a very superior memory. The contents of Picture 2 (Miscellanea) and Picture 3 (Numeral) were rather unorganized and thus lack meaningfulness. They were selected, because the responses the subjects made to these pictures can be marked rather objectively.

Thus, it is very difficult to find out the reasons for the discrepancies in the two studies. Differences resulting from racial, geographical, or cultural factors might also have added to and confounded comparisons between the two studies.

2. The Inference of the Percentage of Eidetic Children

In the present study, 524 subjects were randomly drawn from a population of 130,000 school children in Grades 3 to 6. Of the 524 subjects sampled, 5 were dropped out due to visual and language difficulties, leaving 519 in the sample. Using the "Strict Criteria," 17 or 3.3% of the 519 subjects were classified as eidetic children. However, if the "Less Strict Criteria" were used, 30 or 5.8% of the 519 subjects might be classified as eidetic children. Based on these statistics, the following inferences can be made:

Of the 130,000 students in Grades 3 to 6 in Taipei City, about 4,000 students may be found as "strong" eidetikers and about 7,500 students, "less strong" or "strong" eidetikers. From an educational point of view, these figures are very significant and merit further attention.

3. Eidetic Imagery and Age, Sex, and Intelligence

Since Jaensch (1930) believed that eidetic imagery is more common at lower age levels, many investigators have examined their data for age trends. Contradictory results have been obtained. In Peck and Walling's (1935) study, for example, eidetic imagery was found much more frequently among the preschool subjects (p. 189). However, Allport (1924) pointed out that statistics tend to show that the high point of the eidetic ability is reached in children from 12 to 15 years of age (p. 114). Results such as the one Peck and Walling have obtained tend to support the theory that eidetic imagery has a close relationship with the perceptual development of the children in early childhood (Jaensch, 1930). Results such as Allport has claimed tend to support the theory that eidetic imagery has something to do with the mental state of the children just before their puberty (Friedman, quoted by Klüver, 1928, p. 82).

However, in the present study, the incidence of eidetic children seemed evenly distributed in every age level from 9 to 12. The eidetic subjects did not differ from school population in their ages. As shown in Table 5, the discrepancy between the observed and expected frequencies was not statistically significant ($\chi^2 = 3.29$, df = 3, $p > .50$). Thus the results obtained in the present study supported neither the former theory nor the latter. Perhaps, this is because the subjects used in the present study were not as young as those used in Peck and Walling's study, and at the same time, not as old as the 12- to 15-year-old children Allport mentioned.

Table 5 also shows that no close relationship was found between eidetic imagery and sex. The discrepancy between observed and expected frequencies was also not significant ($\chi^2 = 2.17$, df = 1, $p > .10$). Eidetic imagery does not appear to be especially associated with boys or with girls. This result was the same as that found by Rossler (1928) (see Peck and Walling, 1935, p. 169).

The relationship between eidetic imagery and intelligence as measured by J. C. Raven's Progressive Matrices Test is shown in Table 6. The discrepancy between the observed and expected frequencies was not significant ($\chi^2 = 0.13$, df = 1, $p > .70$). No significant relationship between eidetic imagery and intelligence was found. Eidetikers were not necessarily bright or dull; they were found in every intelligence levels. These results are the same as those found by Rossler (1928). However, the present results are not quite similar to those observed by Klüver (1926) or by Kirek (Klüver, 1928, p. 8). Klüver (1926) found that his subjects were "average or good pupils" according to their teachers' judgment (p. 219). Kirek, as quoted by Klüver (1928, p. 8), asserted that children of the B-type have great difficulties in replacing vivid eidetic image by "abstract concepts" and that children with pronounced eidetic imagery are not likely to be very intelligent.

4. Details, Colors, or Duration of the Eidetic Images

(1) Stimulus Pictures and Details, Colors, or Duration of the Eidetic Images

The results of the analysis of variance in Tables 7, 9, and 11 show that there were significant variations among the five stimulus pictures in eliciting more details, accurate colors, or longer duration of eidetic images (for details, $F = 7.39$, $p < .001$; for colors, $F = 3.46$, $p = .01$; for duration, $F = 3.02$, $p < .05$). The results of Newman-Keuls tests in Tables 8 and 10 show that Picture 3 (Numeral) was significantly less effective than the other four pictures (Silhouette, Miscellanea, Kerchief, and Gardening) in eliciting more details and accurate colors ($p_s < .05$). Picture 3 was also significantly less effective than Picture 5 (Gardening) in eliciting longer durations of eidetic images ($p < .05$) (see Table 12). These results may support the viewpoint that the eidetic-image is subject to the influence of motivational states and changes in the stimulus context. In some eidetic subjects, no image may be formed at all if the content of the picture stimulus does not interest them. Purdy (1936) reported on a subject who found it difficult to obtain eidetic images when nonsense figures were used as stimuli (Richardson, 1969, p. 32). However, Picture 3 in this study, although not interesting, still has an advantage that the eidetic images elicited by it can be objectively rated.

(2) The Individual Differences among Subjects

Even within the Eidetic Group itself there existed great individual differences. The mean ratings of the Details of eidetic images for five stimulus pictures, for example. Of the thirty eidetic subjects, nine were rated 5; two were rated 6; ten were rated 7; eight were rated 8; and one was rated 9. In regard to the mean ratings of the Coloring of eidetic images, six were rated 3; four were rated 4; and twenty were rated 5. As for the mean duration, thirteen subjects had images last over 0.5 to 1.0 minutes; ten, 1.0 to 1.5 minutes; five, 1.5 to 2.0 minutes; one, 2.0 to 2.5 minutes; and one, 2.5 to 3.0 minutes. In some "strong" cases, the duration of eidetic images for some given stimulus picture lasted even longer. The eidetic subject E 22, for example, had his eidetic image last over 292 sec., or about 5 minutes, after Picture 5 (Gardening) was removed. On retest trial, E 1 had his eidetic image last for 518 sec., or about 8.5 minutes, after Picture 5 was taken away.

5. Comparisons of Memory Scores Between Eidetic and Non-Eidetic Groups

Haber and Haber (1964), using the recall method in the test for memory, found that for both accuracy of detail and of color, the eidetic subjects were significantly superior to both the no-image subjects and to the non-eidetic-image subjects (all ts = 2.10, $p < .05$). However, the differences in memory among the three groups were much smaller than expected (p. 137). The authors stated, "Apparently, the eidetic Ss were not using the time during which the image was present to encode the stimulus for later recall, nor were they taking advantage of their practice in reporting the stimulus from their imagery" (p. 138).

In the present study, different methods were used to test the differences between the Eidetic Group and the Non-Eidetic Group in remembering details and colors of Picture 5 (Gardening). The results are shown in Table 13. The recognition score of the Eidetic Group for details was strikingly higher than that of the Non-Eidetic Group. The mean for the latter was 51.67, whereas the mean for the former was 70.67, $t = 3.55$, $p < .001$. As for the redintegration score of colors, the Eidetic Group was also much superior to the Non-Eidetic Group. The mean for the latter was 2.20, whereas the mean for the former was 4.00. The difference was highly significant ($t = 4.14$, $p < .001$). Therefore, in the memory tests for both the accuracy of details and of colors, the eidetic subjects were very significantly better than the non-eidetic subjects, although their intelligence scores were considered the same (see Table 2).

Conclusion

In the present study, 524 subjects were randomly drawn from a population of 130,000 school children of Grades 3 to 6 in Taipei City. Of these subjects, 5 were dropped out due to visual or language difficulties, leaving 519 in the sample. All of the 519 subjects individually participated in the tests for eidetic imagery as well as tests for memory. Two groups, the Eidetic and Non-Eidetic, were established and some inferences were made. The results may be summarized as follows:

1. If the "Strict Criteria" were adopted, 17, or 3.3%, of the 519 subjects might be identified as eidetikers. However, if the "Less Strict Criteria" were adopted, 30, or 5.8%, of the 519 subjects might be classified as eidetic children.
2. The percentage of eidetikers as obtained in the present study (3.3%) was significantly lower than that in the Habers' study (8%). Thus, Hypothesis 1--"There is difference between Chinese and American school children in regard to the prevalence of eidetic imagery," was supported by the present experimental evidence.
3. The eidetic subjects did not differ from the school population in their sex, age, or intelligence.
4. Within the age limits of the present study, 9 to 12 years, the distribution of the eidetic phenomenon was not continuous, but rather discontinuous. The incidence of the eidetic imagery was not universal, but rather relatively rare. However, since the percentage was as high as 3.3% or 5.7%, it was of great educational significance.
5. The nature or content of the stimulus pictures may affect details, colors, or duration of eidetic imagery. In general, stimulus picture of numerals, figures, or color square is uninteresting and thus tends to elicit comparatively poor eidetic imagery.
6. The Eidetic Group was strikingly superior to the Non-Eidetic Group on tests for memory when the recognition method and redintegration method were used.

CHAPTER III

A TEST OF TRAVERS' ASSUMPTION ON EIDETIC IMAGERY

1. Travers' Assumption on Eidetic Imagery

In his book named "Man's Information System," R.M.W. Travers (1970) made an assumption in regard to the phenomenon of eidetic imagery. He said, "Those who have eidetic images, commonly referred to as photographic memories, sometimes show an interference between what they have just attended to and what they are now attending to, perhaps because they have difficulty in getting rid of or erasing stimulus traces" (p. 49). "What this fact suggests is that the eidetiker has difficulty in erasing the trace, and the phenomenon may be a result of the retarded development of the erasure mechanism" (p. 160). "Indeed, one may well hypothesize that eidetic imagery produces problems in that different traces might become confused one with another" (p. 160). The term "erasure mechanism" here is a hypothetical construct, used by Travers to account for the interference between stimulus traces and for the behavior that the eidetiker exhibits. Travers' assumption may be interpreted from different aspects. First, one may interpret Travers' assumption in terms of a neurophysiological model. Usually, the normal metabolic processes consist of two main phases, that is, the anabolic phase and the catabolic phase. The former is a building-up process, and the latter a tearing-down process. Now suppose that when the sensory stimulus enters the eyes, an eidetic person and a non-eidetic person do not differ in the sense that their metabolic processes simultaneously enter into an anabolic phase, and therefore, no manifestation of delay can be found for either side. However, when the sensory stimulus is removed, the metabolic process of a non-eidetic person immediately enters into catabolic phase, while that of an eidetic person still remains in the anabolic phase, presumably due to his "retarded development of the erasure mechanism." His eidetic images last as if the percept of that sensory stimulus were still there. Therefore the percept of the second sensory stimulus might easily interfere with the still on-going eidetic images. Thus, the more sensory stimuli that come from outside, the more severe the confusion between the percepts and the images will be, or even between images and images. One can assume in this case that there is no other way by which an eidetic person can compensate. In addition, one may assume the erasure mechanism to be a biochemical process, occurred in the visual system, probably in the retina, or perhaps, in the central visual area.

Travers' assumption can also be interpreted in terms of an information-processing model by using Sperling's (1963) theory of Visual Information Storage, VIS. Following Sperling, the short-term memory in excess of the immediate-memory span will be called visual information storage (VIS). Normally, the contents of VIS decay rapidly, decay times varying from a fraction of a second to several seconds. Long durations of visual storage can occur in the form of after images which appear to move when the eye moves and therefore are probably localized in the retina (pp. 21-22). Thus, for Sperling, the offset of the stimulus energy is the end of the stimulus, and all further processing of that stimulation uses different aspects of encoded memory (Haber and Haber, 1964, p. 131). If this is true, then, one may assume that eidetic imagery is also one form of visual information storage which does not decay rapidly even after the offset of the stimulus energy. Because of this long-persisting visual information storage, the further processing of the stimulus by using different aspects of encoded memory is delayed. In other words, in the process of translation of stimulation, the eidetiker will lag behind the non-eidetiker.

2. Previous Studies

Some results in previous studies also showed that the different eidetic images may become confused one with another. Jaensch (1930) found that in exceptionally strong cases, particularly in the strictly unitary cases, eidetic images and real object can, under certain conditions, be confused with one another. This is especially the case when objects are of a simple kind (p. 18). As Klüver (1931) reported, as long as a child belongs to the unitary type, his after image, eidetic image, and memory image show the same or a very similar behavior under experimental conditions. Negative after images cannot be produced even after long periods of fixation; memory images pass immediately over into eidetic images. The objects represented in eidetic images closely resemble, and are even mistaken for, objects presented objectively (p. 651). Allport (1924, p. 112) quoted a case reported by Jaensch, in which it was possible to produce a composite or generic eidetic image. Several leaves of snowberry were laid in a row before the subject. He was asked to look intently at the first until an eidetic image was aroused, then to project this image upon the second leaf, and so on until he came to the end of the series. At the end of the series for a large number of subjects there appeared a unique type of synthetic image (p. 112). Haber and Haber (1964) also reported a case in which eidetic imagery occurred when the experimenter showed the next pictures, mistakenly thinking that the subject had indicated that the image to the previous one had faded. After the second picture had been removed, the subject described her eidetic image, which was clearly a fusion of the images of the two stimuli (p. 136). The unusual phenomenon of fusion of successive images was also found in several subjects in Siipola and Hayden's (1965) study. Siipola and Hayden presented two stimulus picture in quick succession and then had subjects view the screen. The pictures were specially designed so that, if fused, a composite image had a different meaning from the separate images. On viewing the screen, over half of the eidetikers described a composite image (p. 283). Both in Haber's (1969) and in Stromeyer's (1970) studies (reported in a previous chapter), it was found that composite or superimposed images were reported by subjects. During tests for eidetic imagery in the present study, similar phenomenon was also found in several subjects. For example, E 20, when reporting his eidetic image for Picture 4 (Kerchief), reported seeing a gentleman with a hat, which was in fact a part of Picture 1 (Silhouette). Subject E 6, when reporting his eidetic image for Picture 3 (Numeral), reported that the image of Arabic numbers might move and run against one another. In an experiment specially arranged for him, he was first asked to scan Picture 1 (Silhouette) to form an eidetic image of it, then to scan Picture 3 (Numeral) to form a second eidetic image, and lastly to scan Picture 4 (Kerchief) to form a third eidetic image. As a result, he reported that the three eidetic images were superimposed--Picture 4 covered over Picture 3 and Picture 1, Picture 4 was the clearest, while Picture 3 and Picture 1 were "Quite in a mess." However, the left end and right end of the Picture 3 were still visible, since it is a horizontal rectangle and Picture 4 is a vertical rectangle in shape. Subject E1 was asked to call up the eidetic images of Picture 1 (Silhouette) and Picture (Numeral), when he was reporting the eidetic image of Picture 4 (Kerchief), after the eidetic images of Pictures 1 and 3 faded. He finished this without difficulty, but reported that the images were confused all together. He could either put the eidetic image of Picture 1 atop and cover over Picture 4, or put the eidetic image of Picture 4 atop and cover over the eidetic images of Pictures 1 and 3.

3. Hypotheses 2 to 5 of the Present Study

Judging from the studies mentioned above, we know it is possible for the confusion or interference of images to occur. These studies, however, appearing to be primarily descriptive and lacking in theoretical bases. The purpose of this chapter is to describe four experiments undertaken to test the experimental hypotheses which are derived from Travers' assumption on eidetic imagery. If the hypotheses upon which the experiments are based escape being disconfirmed by the experimental evidence, then Travers' assumption may have more favorable empirical support. The rationale here is that because of a retarded erasure mechanism, images from antecedent stimuli continue to persist for a relatively long time and then accumulate, overlap, or superimpose with the images, or even the percepts, of the succeeding stimuli.

Now, the Hypotheses 2 to 5 of the present study are as follows:

Hypothesis 2. The reaction time to the offset of the visual stimulus for the eidetic subjects is significantly longer than that of the non-eidetic subjects.

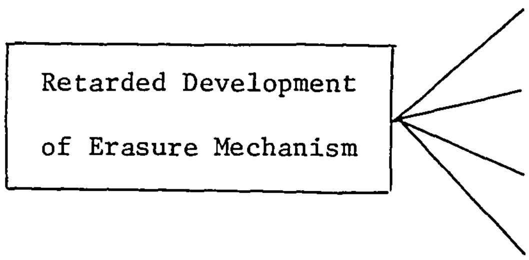
Hypothesis 3. Under a situation with visual stimuli of high similarity, the search time for the absence of target stimulus of the eidetic subjects is significantly longer than that of the non-eidetic subjects.

Hypothesis 4. The incidences of the composite and the superimposed images for the eidetic subjects are significantly more frequent than those for the non-eidetic subjects.

Hypothesis 5. In an EEG test, the post-stimulation alpha recovery time for the eidetic subjects is significantly longer than that for the non-eidetic subjects.

We may diagram as follows to show that the retarded development of an erasure mechanism accounts for the interference of the stimulus traces:

Hypothetical Construct — Behavioral Indices



(1) Slower reaction time to the stimulus offset.

(2) Longer search time for the absence of target stimuli.

(3) Greater incidence of composite and superimposed images.

(4) Longer post-stimulation recovery time of alpha wave.

4. The Overall Experimental Design of the Present Study

In the following sections, Experiment 1 will be undertaken to test Hypothesis 2; Experiment 2, to test Hypothesis 3; Experiment 3, to test Hypothesis 4; and Experiment 4, to test Hypothesis 5.

Because of the special nature of the present study, the method of random assignment of subjects to different groups is not applicable. In other words, the eidetic subjects are "assigned" to the Eidetic Group simply because of the fact that they have an eidetic disposition which is the main variable in the present study. Secondly, it is impossible to match the two groups on the basis of such factors. However, in order that objective comparisons can be made, the two groups, the Eidetic Group and Non-Eidetic Group, were matched on the bases of sex, age, and intelligence. They are not entirely equivalent, however, especially where the experimental variables in a given experiment are concerned. Thus, after each experiment, results are analyzed by means of statistical methods, such as the analysis of covariance, so that the possible errors which might have been caused by non-random assignment may be minimized. In other words, in the following experiments, statistical controls are used after experimental controls have been undertaken.

EXPERIMENT 1

A COMPARISON BETWEEN THE EIDETIC AND NON-EIDETIC GROUPS ON THE REACTION TIME TO THE OFFSET OF THE VISUAL STIMULUS

A corollary of Travers' assumption may be stated as follows:

If there is no difference between the Eidetic Group and the Non-Eidetic Group on the reaction time to the onset of the visual stimulus, the Eidetic Group may be slower than the Non-Eidetic Group in terms of the reaction time to the offset or cessation of the visual stimulus. The rationale is that because of the retarded development of the erasure mechanism, and because of their vivid eidetic images, the eidetic children will find it difficult to detect the disappearance of the visual stimulus when the visual stimulus is removed. For non-eidetic children, however, this will not occur. As a result, the reaction time to the offset of visual stimulus will be longer for the eidetic children than for the non-eidetic children. Hypothesis 2 is based on these arguments and will be tested in Experiment 1.

Method

Subjects. The subjects were the 30 eidetic children, selected by the "Less Strict Criteria" and the 30 non-eidetic children who were matched individually with the eidetic children on the bases of sex, age and intelligence (see Table 2). The two groups, Eidetic Group and Non-Eidetic Group, were equal in age and intelligence, but they were not equivalent in variables such as finger dexterity and sensory-motor cooperation, which are considered to be related to reaction time.

Apparatus. The apparatus used in the present study is schematically shown in Appendix B. It consisted of a Decade Interval Timer (Model III-C, Series D; Hunter Co.), a stimulus lamp (4.5 W, signal lamp as an accessory of the 23307 Reaction Timer; Stoelting Co.), a chronoscope or a clock timer (Stoelting Co.), subject's telegraph key, experimenter's onset-offset knife switch, and a dry battery (6 volts).

A decade interval timer was used to adjust and vary the foreperiod. The subject responded to the red signal lamp which was operated by direct current supplied from the dry battery, by lifting his finger off the telegraph key. The subject's reaction time could be read from the chronoscope in hundredths of a second. When the knife switch was thrown to the "Onset" position, the apparatus could be used for the Onset Reaction Time experiments; and when switched to the "Offset" position, for the Offset Reaction Time experiments.

Procedures. Both the Eidetic Group and the Non-Eidetic Group participated in the following two sessions of experiment:

(1) Onset Reaction Time Experiment

The subject was seated by a table with the reaction time apparatus on it. The experimenter threw the knife switch to the "Onset" position. After he had adjusted the decade interval timer for the proper foreperiod, the experimenter said "Ready." The subject was asked to press his telegraph key immediately. At the same time, the experimenter started the decade interval timer by pressing the lever of the on-off switch. When that proper foreperiod was over, the red signal lamp would light and simultaneously the chronoscope start. The subject released the telegraph key as soon as possible after he had perceived the presentation of the signal. When he released the telegraph key, the chronoscope stopped and the experimenter wrote down the reaction time. By "reaction time," was meant the time elapsed from the beginning of the signal to the beginning of the key-releasing response.

Each subject was given 42 consecutive trials, with no rest between trials. The foreperiods between the "Ready" warning and the stimulus were varied from 3 to 5 sec. (in a random order decided beforehand) so that the subject might be prevented from responding to the foreperiod interval per se (which he might do if it was constant).

(2) Offset Reaction Time Experiment

The second session began after the subject had taken a rest for 10 minutes. The experimenter threw the knife switch to the "Offset" position. He adjusted the decade interval timer and said "Ready." The subject also pressed the telegraph key immediately. At the same time, the experimenter started the interval timer to time the foreperiod and simultaneously to light up the signal lamp. When the given foreperiod was over, the signal lamp would be off, and the chronoscope would be started simultaneously. The subject responded to the offset of the signal stimulus by releasing the key as quickly as possible. The experimenter took down the reaction time after the chronoscope had stopped. Each subject also was given 42 consecutive trials, with no rest between trials. The foreperiods were also varied from 3 to 5 sec.

Results

For each subject, two of the longest reaction times in the Onset session and two of the longest reaction times in the Offset session were discarded, leaving 40 trials for each session. The means of reaction time, one for Onset trials, one for Offset trials, were calculated. As mentioned above, though the eidetic children and the non-eidetic children did not differ in age and intelligence, they were not considered as equivalent in those variables related with reaction time, such as finger dexterity and sensory-motor cooperation, etc. For this reason, it was necessary to use analysis of covariance to analyze the data obtained. Table 14 presents the results of the analysis of covariance, using the mean reaction time for Onset trials as the covariate and the mean reaction time for Offset trials as the criterion. A .05-level test on the Between Groups in analysis of covariance indicated statistically

Table 14. The Analysis of Covariance of the Mean Reaction Time to the Offset of Stimulus by the Eidetic and Non-Eidetic Groups

Source	Adjusted Variation	df	MS	F
Between	44.28	1	44.28	6.21*
Within	406.97	57	7.14	
Total	451.25	58		

$^*F_{.95}(1,57) = 4.00$

significant difference between the criterion means, $F = 6.25$. Table 15 indicates the adjusted means and the unadjusted means of reaction time to the offset of signal stimulus for the two groups. The adjusted means

Table 15. Adjusted Means and Unadjusted Means of the Reaction Time (1/100 Sec.) to the Offset of Stimulus by the Eidetic and Non-Eidetic Groups

	Unadjusted Means		Adjusted Means
	Onset ($\overline{X}_j$)	Offset ($\overline{Y}_j$)	Offset ($\overline{Y}'_j$)
Eidetic Group	29.97	29.17	29.75
Non-Eidetic Group	31.27	28.57	28.00

were obtained by the formula:

$$\overline{Y}'_j = \overline{Y}_j - b\ (\overline{X}_j - \overline{X}),$$

Where, $b = .87$. Judging from these results, we know that the mean reaction time to the offset of the stimulus for the eidetic children was significantly longer than that for the non-eidetic children. The Eidetic Group, $\overline{Y}' = 297.5$ msec., and for the Non-Eidetic Group, $\overline{Y}' = 280.0$ msec.

If the group classes were disregarded, the correlation between the covariate and the criterion was .88, $p < .01$. Hence, it was meaningful to have used the reaction time to the onset of stimulus as the covariate.

In order to test whether the reaction time to the offset of stimulus for the two groups of children will differ more and more as the experiment continued, a <u>test for trend</u> was performed. Here, the rationale is that as the number of trials increases, the eidetic images of the eidetic

Table 16. The Analysis of Variance for the Four Blocks of Reaction Time to the Offset of Stimulus by the Eidetic and Non-Eidetic Groups

Source of Variation	SS	df	MS	F
Between Subjects	8167.21	59		
A: Groups	16.51	1	16.51	
S(A): Subject within groups	8150.67	58	140.53	
Within Subjects	1510.75	180		
B: Blocks	94.15	3	31.39	4.02**
AB: Groups x Blocks	58.44	3	19.48	2.50*
S(A)B: Blocks x subjects within groups	1358.16	174	7.81	
Total	9677.96			

** $p < .05$ * $.10 > p > .05$

children will accumulate. As a result, the vivid images will become more and more, and the reaction time to the offset of the visual stimulus will become longer and longer. The 40 trials of the reaction time to the stimulus for each subject were divided into four successive blocks of 10 trials. From these 4 successive blocks, four means were obtained for each subject. The data thus obtained were first analyzed by means of an analysis of variance (Winer, 1962, pp. 302-312). The results are as shown in Table 16 and Table 17. Then, a test for trend was performed. The linear trend in the main effect of factor Blocks differed

Table 17. The Totals of Means for Four Blocks of Reaction Time to the Offset of Stimulus by the Eidetic and Non-Eidetic Groups (in 1/100 sec.)

	Block 1	Block 2	Block 3	Block 4	Total
A_1: Eidetic Group	827	867	900	904	3498
A_2: Non-Eidetic Group	851	858	881	845	3435
Total	1678	1725	1781	1749	6933

significantly from zero, $F = \frac{MS_{B(lin.)}}{MS_{S(A)B}} = \frac{60.30}{7.81}$ $= 7.72$, $p < .01$ (Neither the quadratic nor the cubic trend in the main effect was significant. $F = \frac{MS_{B(quad.)}}{MS_{S(A)B}} = \frac{26.00}{7.81} = 3.33$, $p > .05$; $F = \frac{MS_{B(cubic)}}{MS_{S(A)B}} = \frac{7.85}{7.81} = 1.00$, n.s.). However, the primary interest here was in the possible difference in the trends of the trial means for the subjects in the Eidetic and the Non-Eidetic Groups. This was tested by $F = \frac{MS_{AB(lin \times lin)}}{MS_{S(A)B}} = \frac{55.90}{7.81} = 7.16$, $p < .01$. This result implied that the two linear components significantly differed. In other words, profiles were not parallel. The slope of trend for the Eidetic Group was steeper than that for the Non-Eidetic Group (Winer, 1962, pp. 273-278; Edwards, 1967, pp. 308-316).

Discussion

According to Woodworth and Schlosberg (1958), the response to be observed at any moment depends on the external situation affecting the organism and on factors present within the organism at that moment (pp. 16-39). This statement is applicable to the present experiment. Thus, the external factors which may influence the eidetic phenomenon under study were well controlled by holding the experimental conditions constant for both the Eidetic and Non-Eidetic Groups. The internal factors excepting the independent variable, presence or absence of eidetic imagery, were controlled by using the analysis of covariance.

We know from Table 14 that Eidetic Group and Non-Eidetic Group differed significantly in their reaction time to the offset of stimulus, $F = 6.21$, $p < .05$. Judging from the adjusted means obtained in Table 15, we know that the mean reaction times for the Eidetic Group ($\bar{Y}' = 297.5$ msec.) were significantly longer than that of the Non-Eidetic Group ($\bar{Y}' = 280.0$ msec.). Therefore, Hypothesis 2, "The reaction time to the offset of the visual stimulus for the eidetic subjects is significantly longer than that of the non-eidetic subjects," could be supported by the obtained experimental evidence. It is possible that between the erasure mechanism and the slowness of reaction time to the offset of stimulus there exists some sort of concomitant, or even causal, relationship.

Furthermore, if Travers' assumption is correct, we may also deduce that as the number of trials increases, the eidetic children will have more and more vivid images, and therefore, their reaction time to the offset of the visual stimulus will become increasingly longer. If this kind of progressive error, or more precisely, the fatigue effect, does occur, we may infer that this fatigue effect has been caused by the retarded erasure mechanism. This was tested by dividing each subject's 40 trials into consecutive blocks of 10 trials, and then subjecting the data to a test of trend.

In fact, Table 16 shows the results of a 2 x 4 factorial experiment with repeated measures on the second factor, Blocks. The main effect of Blocks was significant, $F = 4.02$, $p < .05$ (see Table 16). The result of the test for trend showed that the linear trend in the main effect of Blocks was highly significant, $F = 7.72$, $p < .01$ (see Table 17). However, our primary interest was in the possible differences in the trends of the trial means for the Eidetic and Non-Eidetic Groups. The test of differences in trends showed that the two linear components differed significantly, $F = 7.16$, $p < .01$. This result is indicated in Figure 2.

For the Non-Eidetic Group, the block means were 283.7 msec., 286.6 msec., 293.6 msec., and 281.7 msec. respectively. These four block means for the Non-Eidetic Group almost formed a flat line. This pointed to the fact that there was no manifestation of fatigue effect during the 40 trials of reaction time experiment. On the other hand, for the Eidetic Group, the block means were 275.7 msec., 289.0 msec., 300.0 msec., and 301.3 msec. respectively. This indicated that as the experiment progressed, the reaction time to the offset of the stimulus for the eidetic children became increasingly longer. The predicted interaction effect did occur. The result also supported Hypothesis 2, and indirectly, Travers' assumption.

Summary

Thirty eidetic children and 30 non-eidetic children participated in an experiment on the reaction time to the onset of visual stimuli and an experiment on the reaction time to the offset of visual stimuli. The

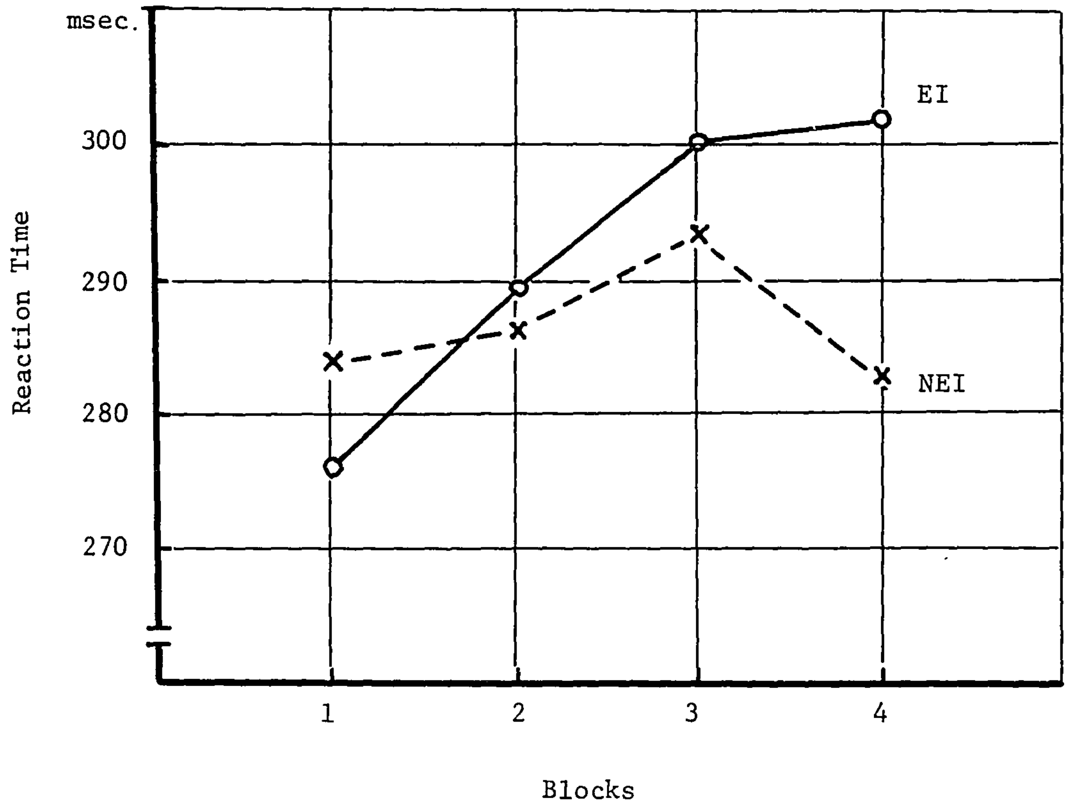


Figure 2. The Difference in the Trends of the Trial Means for the Eidetic and Non-Eidetic Groups.

results may be summarized as follows:

1. The results of analysis of covariance, using measures obtained in the onset session as covariate, showed that the mean reaction times to the offset of visual stimuli for the eidetic children was significantly longer than that of the non-eidetic children. Hypothesis 2, "The reaction time to the offset of the visual stimulus for the eidetic subjects is significantly longer than that of the non-eidetic subject," was supported by the experimental evidence.

2. The test of differences in trends showed that as the experiment progressed, the reaction time to the offset of the visual stimulus for the eidetic children became increasingly longer. However, the reaction times to the same stimulus for the non-eidetic children stayed about the same, with no manifestation of a fatigue effect. It is possible that because of the retarded erasure mechanism assumed by Travers (1970), the eidetic images accumulated more and more as the experiment progressed, and this might have had a deleterious effect on the behavior of the eidetic children in the experiment on reaction time to the offset of the visual stimulus.

EXPERIMENT 2

A COMPARISON BETWEEN THE EIDETIC AND NON-EIDETIC GROUPS ON THE SEARCH TIME FOR THE ABSENCE OF TARGET LETTERS

Visual verbal-stimuli, such as numerals, phonetic symbols, and letters of the English alphabet, sometimes cause perceptual confusions if their similarity is high (Gibson, et al., 1963; Popp, 1964; Dunn-Rankin, 1968). Neisser (1966) has shown that similarity is a relevant and potent factor in search behavior (pp. 66-71).

With this notion that the high similarity of visual verbal-stimuli can cause confusions, we may make a further deduction from Travers' assumption. We may assume that given a situation with visual verbal-stimuli of comparatively low similarity, the search time for the eidetic children will be about the same as that for the non-eidetic children, presumably because for the eidetic children there are still distinguishable differences between the percepts of those stimuli and the eidetic images of those stimuli. However, under a situation with visual verbal-stimuli of comparatively high similarity, the search time for the eidetic children will be significantly longer than that for the non-eidetic children, presumably because the percepts of those stimuli look too similar to the images of those stimuli and thus confusions may occur between the percepts and the images, or among images themselves. If Travers' assumption is appropriate and if the deduction above is correct, Hypothesis 3 should result in positive support from experimental evidence.

Method

Subjects. The same 30 eidetic children and 30 non-eidetic children used in Experiment 1 also participated in the present experiment. These two groups were again not considered as equivalent in those variables related to the search time task, although they were matched on age, sex, and intelligence.

Materials. A page of visual verbal-stimuli, consisting of two columns of Arabic numerals, two columns of Chinese phonetic symbols, and two columns of upper-case English alphabet letters was used as material (see Appendix C). Above each column, there was a "target letter." For example, the target letter for the two columns of English alphabet was Q. The letter Q appeared both in the first column and in the second column of the English alphabet. The material was arranged in such a way that if the Q appeared in the first column, in a context of low similarity, it could be found out easily. However, if it appeared in the second column, in a context of high similarity, it could not be searched out as easily. Since the letter Q can be thought of as having circular form, if it occurs in a context of circular-like letters, such as C, D, G, O, R, and U, it will not be as easily found than it will be when it occurs in a context of angular-like letters, such as E, I, M, V, W, and X (see Underwood, 1966, p. 279). Besides the uppermost eight items, which were used as examples for the subject, there were 50 items in each column. Of these 50 items, there was an item in which there was no target letter Q. The subject was asked to detect the *absence* of this target letter. The other columns for Arabic numerals and for Chinese phonetic symbols were also arranged in a similar fashion.

Procedure. The subject was seated in a room, with the daylight coming indirectly from the left side of him. The list for visual searching was put on a table in front of the subject. The whole list, except the target word and the eight example items at the top of the column, was shielded from viewing with a sheet of paper. The following instruction was given.

"We are going to play a game with numerals. Here (pointing) is an '8' at the top of the column. I want you to search from the eight items [pointing to the example items] for an item without an '8' in it. You must start at the top of the column and proceed downward as rapidly as possible until you find it. When you find an item without '8' please say 'I found it' and at the same time point to that item. If you proceed downward and find no such an item, please go back and start from the top of the column."

After the subject had done the example and understood the searching method, the experimenter said "Ready" and removed the shielding paper. At the same time he said, "Begin" and started to measure the search time by using a stop watch. He stopped the watch when the subject said "I found it" and did find the absence of the target stimulus. Thus, by "search time," we meant the interval from the time the "Begin" signal was given to the time the subject reported "I found it."

The other columns were also presented in the same manner.

Results

Table 18 shows the total search time for the absence of the target stimulus by eidetic children and by non-eidetic children. The table also shows the experimental design of the present experiment. The individual scores by which the cell totals in Table 18 were calculated were used as the raw data for analysis of covariance in Table 19. Thus the present experiment comprised a 2 x 3 analysis of covariance, with the second variable, <u>Target Stimuli</u>, as repeated measures (see Winer, 1962, pp. 606-618). Since the Eidetic and Non-Eidetic Groups were not considered as

Table 18. The Total Search Time (Sec.) for the Absence of Target Stimuli by the Eidetic and Non-Eidetic Groups

	B_1 : 8		B_2 : [illegible]		B_3 : Q		Total	
	X	Y	X	Y	X	Y	X	Y
A_1: Eidetic Group	881	1571	1197	2222	542	894	2620	4687
A_2: Non-Eidetic Group	1039	1437	1221	2153	661	974	2921	4564
Total	1920	3008	2418	4375	1203	1868	5541	9251

equivalent so far as the variables related to search reaction were concerned, the analysis of covariance was applied. The X'_s in Table 18 represent covariates, that is, the search time for the absence of the target stimulus in a context of low similarity. The Y'_s represent criteria, that is, the search time for the absence of the target stimuli under a context of high similarity.

Table 19. The Analysis of Covariance on Search Times for the Absence of Target Stimuli by the Eidetic and Non-Eidetic Groups (Less Strict Criteria)

Source	Adjusted Variation	df	MS	F
A: Groups	1139.44	1	1139.44	3.68*
Subj. w. gr.	17659.99	57	309.82	
B: Targets	9377.21	2	4688.61	19.04**
AB: Groups x Targets	523.46	2	261.73	1.06
Residual	28314.56	115	246.21	

* $.10 > p > .05$ $F_{.95(1,57)} = 4.00$ ** $p < .001$

From Table 19 we see that although the observed F statistic, F = 3.68, for the variable <u>Groups</u> did not exceed the critical value for a .05-level test, $F_{.95(1,57)} = 4.00$, it was very near to this value.

Table 20. Adjusted Means of the Search Times (Sec.) for the Absence of Target Stimuli by the Eidetic and Non-Eidetic Groups (b = .79)

	8	ㄣ	Q	Total Means
Eidetic Group	52.16	65.55	38.52	52.08
Non-eidetic Group	46.19	65.26	40.71	50.72
	49.18	65.41	39.62	

Inspection of Table 20 indicates that possibly there was a significant difference between the Eidetic and Non-Eidetic Groups with regard to the search time for the absence of target stimulus "8". Thus, the data for the part of Arabic numeral was separately taken out and subjected to an analysis of covariance. Table 21 shows the result. Since F = 4.95,

Table 21. The Analysis of Covariance on the Search Times for the Absence of the Target Stimulus "8" by the Eidetic and Non-Eidetic Groups

Source	Adjusted Variation	df	MS	F
Between	1490.62	1	1490.62	4.95*
Within	17157.36	57	301.01	

$*F_{.95(1,57)} = 4.00$

$p < .05$, we know that the search times for the absence of "8" for the two groups of children differed significantly. However, since this was an <u>a posteriori</u> test, the level of significance must be adjusted accordingly. That is, when we stated that the search time for the absence of "8" for the eidetic children was longer than that for the non-eidetic children, the probability of type 1 error's occurring in one <u>or</u> more of the decisions is $1 - (.95)^3 = .143$.

Because the analysis in Table 19 yielded only a near-significant difference between the 30 eidetic children and the 30 non-eidetic children, it was decided to compare the search time of the 17 eidetic children selected by the "Strict Criteria" and the 17 non-eidetic children with whom the eidetic children were matched. The difference

Table 22. The Analysis of Covariance on the Search Times for the Absence of Target Stimuli by the Eidetic and Non-Eidetic Groups (Strict Criteria)

Source	Adjusted Variation	df	MS	F
A: Groups	909.74	1	909.74	4.17*
Subj.w. gr.	6757.70	34	217.99	
B: Targets	3068.59	2	1534.30	7.60**
AB: Groups x Targets	557.05	2	278.53	1.38
Residual	12722.92	63	201.95	

*$p < .05$, $F_{.95(1,30)} = 4.17$ **$F_{.99(2,63)} = 4.98$

between them were tested in Table 22, by means of the analysis of covariance. The results show that the difference between groups was statistically significant, $F = 4.17$, $p < .05$. Since the interaction between Groups and Targets was not significant, $F = 1.38$, $p > .05$, no further analysis was undertaken.

Discussion

In this experiment, the experimenter assumed that in a situation with a context of low similarity, there will be no differences in search time for the target stimuli between the Eidetic Group and Non-Eidetic Group. However, in a situation with a context of high similarity, the search time for the eidetic children may be significantly longer than that for the non-eidetic children. Presumably, because of the retarded erasure mechanisms, the images of the eidetic children will become so vivid that they may confuse the percepts of the context stimuli. This deduction of Travers' assumption lead to Hypothesis 3 which was tested by the present experiment. However, the results as reported in Table 19 were that the adjusted variation between Eidetic Group and Non-Eidetic Group was not significant, $F = 3.68$, $.10 > p > .05$. The fact that the difference between the two groups approached significance [$F_{.95(1,57)} = 4.00$] indicated the possibility of a type 2 error, that is, a true difference between the two groups that was not detected by the statistical test. Thus, an additional analysis was conducted using as eidetic subjects only those who had exceeded the "Strict Criteria." Such an analysis, as shown in Table 22, yielded a significant difference between the 17 "strong" eidetic children and their counterparts, the 17 non-eidetic children, $F = 4.17$, $p < .05$. Since the interaction, Groups x Targets, was not statistically significant, we may say that, in general, the search time for the absence of the target stimuli for the 17 eidetic children was significantly longer than that for the 17 non-eidetic children.

Thus, it seems that the predicted confusion phenomenon between the images and the context stimuli may occur only when the eidetic disposition is strong enough to meet the "Strict Criteria" of the present study. If this is true, we may then assume that in a situation with a context of high similarity, the eidetic children might have used some kinds of compensating mechanism or other possible alternatives so that their eidetic images did not confuse with the percepts of the context stimuli. However, we need further study of this possible compensating mechanism.

Summary

Subjects were asked to look for the absence of target stimuli, "8", "ㄌ", and "Q" from a context of low similarity and from a context of high similarity. The results of analysis of covariance showed that:

1. There was no significant difference in the search time for the absence of target stimuli between the 30 eidetic children selected by the "Less Strict Criterion" and their 30 non-eidetic counterparts.
2. However, there was a statistically significant difference in the search time for the absence of target stimuli between the 17 eidetic children selected by the "Strict Criterion" and their 17 non-eidetic counterparts.
3. Thus, whether or not Hypothesis 3 ("Under a situation with visual stimuli of high similarity, the search time for the absence of the target stimuli of the eidetic subjects is significantly longer than that of the non-eidetic subjects,") will be accepted depends upon the strictness of the selection criteria we used to screen the eidetikers.
4. It is possible that the eidetic children used some kind of compensating mechanism so that the eidetic images might not be confused with the percepts of the context stimuli. It is worthwhile to pursue this possibility further.

EXPERIMENT 3

A COMPARISON BETWEEN THE EIDETIC AND NON-EIDETIC GROUPS ON SUPERIMPOSED IMAGES BY TESTS OF COMBINATION PICTURES, DOT NUMBERS, FLOATING FIGURE, AND SPIRAL AFTEREFFECT

The statement that eidetic imagery is nothing but a kind of superior memory acquired according to learning principles in the individual's past history has been a very powerful criticism against the researchers of eidetic phenomenon. A great deal of effort has been made to defend against such criticism.

Haber (1969) tried to develop a test for the screening of eidetic imagery that did not depend on verbal facility and could not be biased by memory. The main technique he used was a sequence of pictures that together formed another picture. The first picture was designed in such a way that if it was superimposed on a second picture, a third picture was formed by the combination. It was assumed that the combination picture was unpredictable from either picture alone. The one way the eidetic child could know what the combination was is if he could visually superimpose one picture on the other. If he viewed the pictures separately, this could be accomplished only by maintaining an image of the first picture long enough to superimpose it on the second one (p. 44). Stromeyer (1970), however, argued that the test used by Haber (1969) still could not distinguish between superior memory and a projected eidetic image. Thus, he developed some ingenious techniques designed to reduce memory to a lower extent. In a test using a random dot pattern, for example, his subject was asked to view with her right eye a computer-generated 10,000-dot pattern until she formed an eidetic image. Then she closed her right eye and opened the left eye to see another 10,000-dot pattern. Keeping her right eye closed, she tried to visualize the image of the right-eye pattern, while she was viewing the left-eye pattern. At last she reported that she saw the letter T floating toward her. The subject accomplished this without using a steroscope (pp. 77-88). By these kinds of techniques, both Haber (1969) and Stromeyer (1970) proved that eidetic imagery did exist.

In the following sections, parts of Haber's and Stromeyer's techniques will be applied to test Hypothesis 4. We make a further deduction from Traver's assumption that because of the retarded erasure mechanism, an eidetic child may maintain his eidetic image long enough to superimpose it on the other image, or on a picture. And, therefore, the incidence of the composite or superimposed image for the eidetic children will be more than those for the non-eidetic children. For this reason, we may expect that the eidetic children will succeed more than the non-eidetic children in the following tests, which have been modified in some way so that it would be applicable to the subjects of the present study.

Method

Subjects. The subjects were the 30 eidetic children selected by the "Less Strict Criteria" and their counterparts, the 30 non-eidetic children.

Apparatus and Materials

(1) Test for "Combination Picture"

A variation of Haber's test was used. The materials were seven sets of 3 slide pictures. The third slide in each set was blank and was neutral gray in color. The first two slides of each set were designed in such a way that if the first slide was superimposed on the second one, a combination picture would be formed. Thus if the first, the second, and the third slides were presented to the subject successively, it was expected that an eidetic child might see a combination picture on the third slide which was in fact blank. The first of the seven slide sets was used as example. The names and the contents of the other six sets are described or illustrated as follows:

1. "Triangle": The first slide was of an upright triangle--the figure in yellow and the ground in blue. The second slide was of a reversed triangle--the figure also in yellow and the ground in blue. The third slide was blank and was neutral gray in color.
2. "83": The first slide was of a white Arabic number "8" appearing at the left side against a red ground. The second slide was of a white "3" appearing at the right side against a red ground. The third slide was blank and gray.
3. "Four": The first slide was of a white Chinese character "儿" appearing in the center against a red ground. The second slide was of a white "囗", also appearing in the center against a red ground. The third slide was blank and gray. An eidetic child was expected to see a Chinese character "四", four, on the third slide.

4. "Rat-Man": The first two slides, as shown in Figure 3(a), were modified from Bugelski and Alampay (1961)'s "Rat-man figure." The figures were in black, and the grounds, in yellow. The third slide was blank and gray.
5. "Clown-face": The first two slides, as illustrated in Figure 3(b), were modified from Haber (1969) Recognition Test (p. 44). Both were black and white. The third slide was blank and gray.
6. "Alligator and Boy": The first two slides, as illustrated in Figure 3(c), were modified from Klüver (1926). Both were black and white. The third slide was blank and gray.

(2) Test for "Dot Numbers"

A pair of 101 random-dot patterns, as illustrated in Figure 4, were used as materials. The two random-dot patterns, being modified from Stromeyer's (1970, p. 78 & p. 80) Test 1, was designed in such a way that if they were superimposed, and their rectangular borders coinciding exactly, the figures "53" appeared. Each rectangule, 9 cm. x 12 cm. in size, was separately mounted on a black cardboard. To be presented to the subject, it was put upon the same display-board used during the test for eidetic imagery.

(3) Test for "Floating Figure"

The material used here was a stereogram developed by Shimazu Mfg. Co., Kyoto, Japan (see Figure 5). When a person looks at this stereogram through a stereoscope, which presents the left-eye pattern to the left eye and the right-eye pattern to

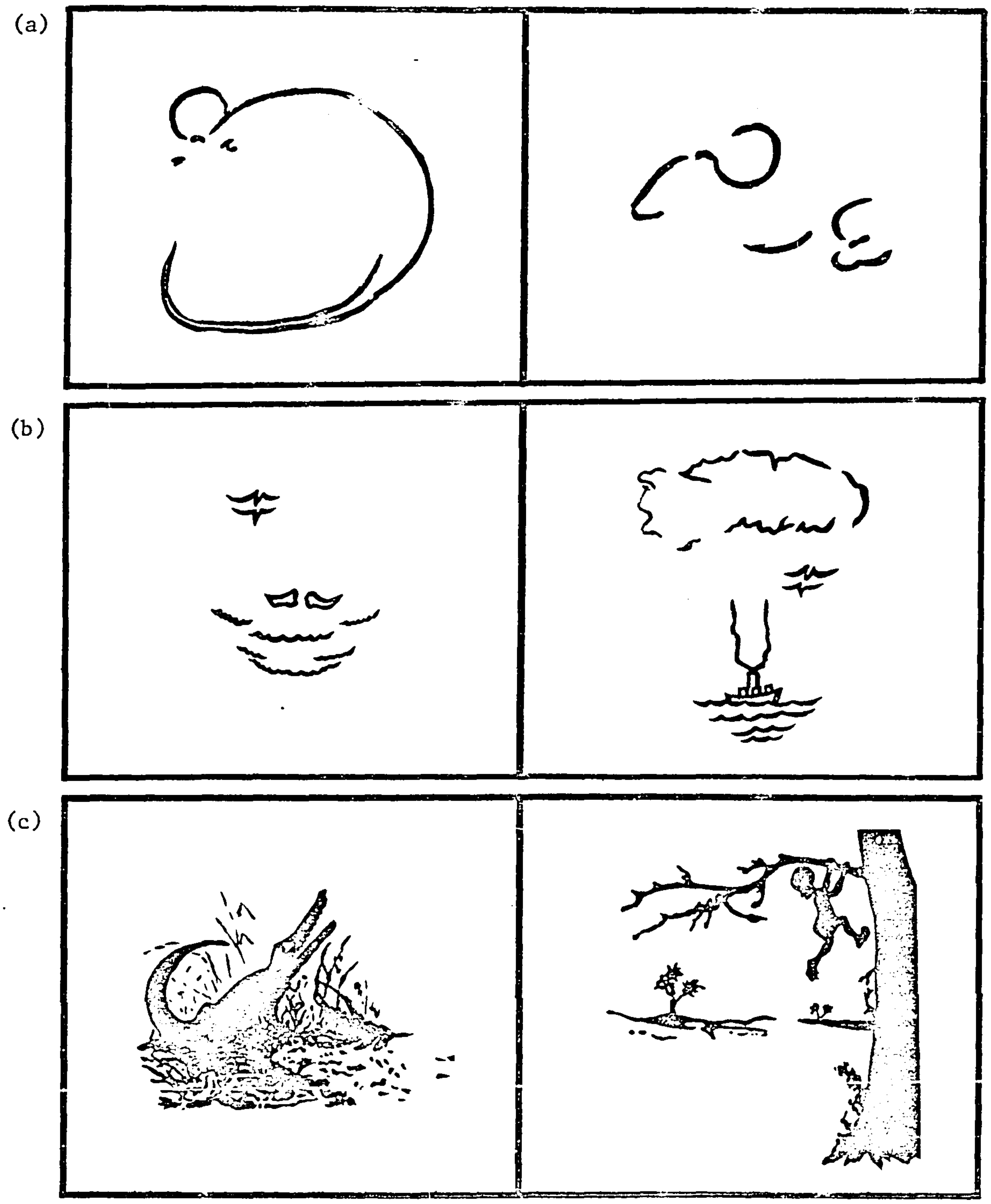


Figure 3. A Part of the Slide Pictures Used in the Test for "Combination Picture." (a), Rat-Man; (b), Clown-face; (c), Alligator and Boy. (Sources, see text.)

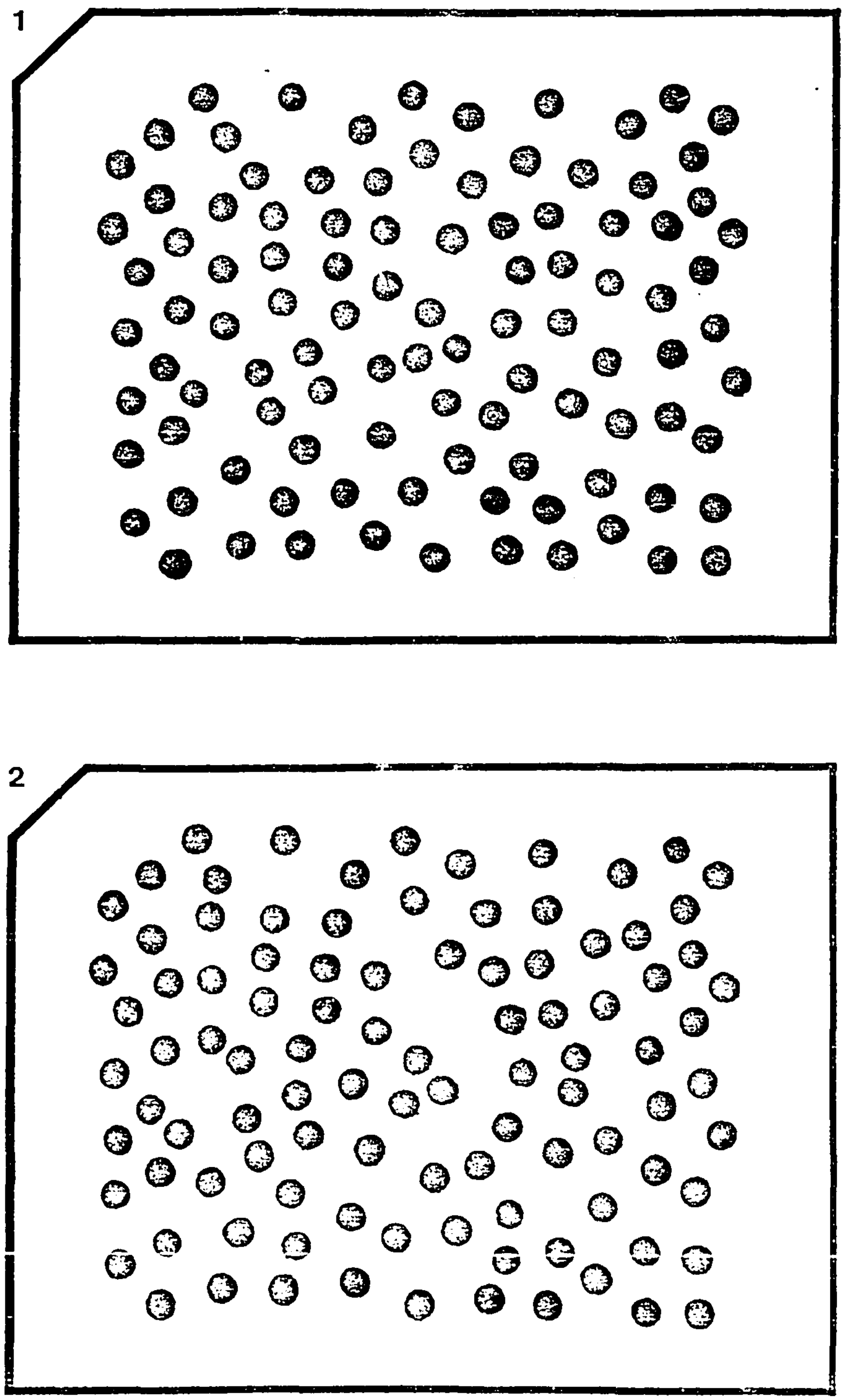


Figure 4. Materials Used in the Test for "Dot Numbers."
(Modified from Stromeyer III, 1970.)

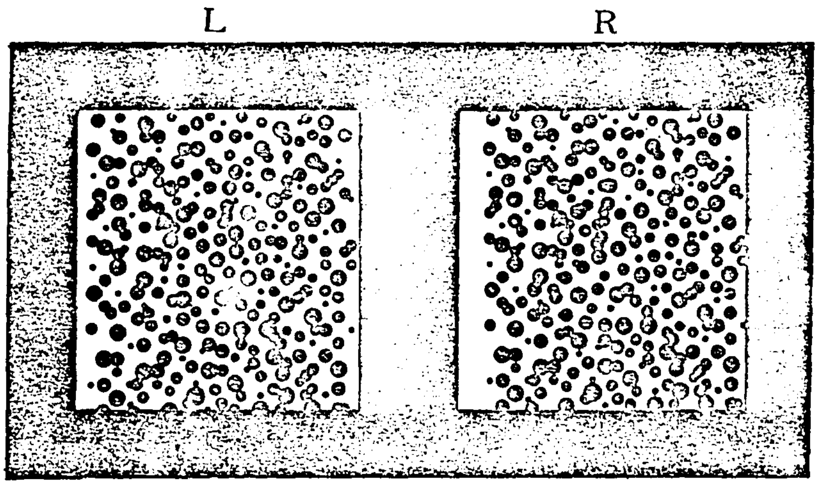


Figure 5. Material Used in the Test for "Floating Figure." In th present experiment, the left-eye pattern and the right-eye pattern were separately mounted on different cardboards with black ground (Shimazu Mfg. Co., n. d.)

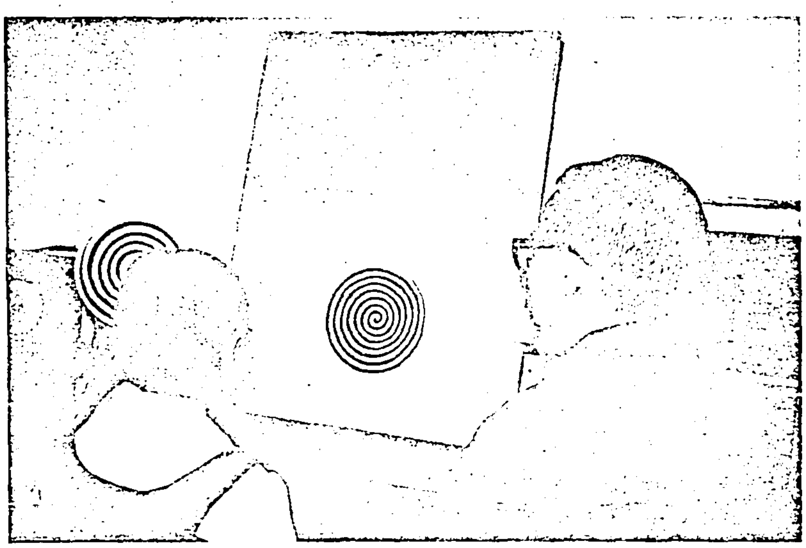


Figure 6. An Actual Setting of the Test for "Spiral Aftereffect."

the right eye, he sees a figure 'Ɫ' emerge in depth. When he looks at the stereogram without the stereoscope, he can see neither figure nor depth. In the present experiment, the right-eye pattern and the left-eye pattern (each 3.7 cm. x 4.0 cm.) were separately mounted on different cardboards (also black in color). To be presented, it was separately attached on the display-board.

(4) Test for "Spiral Aftereffect"

The materials and apparatus used here included a color wheel, two spiral disks, and the display-board (see Figure 6). The spirals were designed in such a way that if the spiral disks were rotated clockwise on the color wheel, they would appear to contract. However, one of the two spirals was never rotated on the color wheel. It was put onto the display-board only. Therefore, it was called "the stationary spiral." When a person looked at the rotating-contracting spiral for a few minutes and then stared at the center of the stationary spiral, the stationary spiral would seem to expand. He was said to have experienced apparent movement. However, we called this phenomenon spiral aftereffect in the present study. The actual diameter of the spiral disk was 20 cm.

Procedure

(1) Test for "Combination Picture"

The subject was seated before and 150 cm. away from the screen in a dark room. A slide projector was put at the left of, but about 20 cm. behind, the subject. The experiments were undertaken in the following two stages:

1. Non-Suggestion Stage:

Making use of the Example slide set, the experimenter described and explained to the subject the ways of viewing the slide picture. The following instructions were given:

"I am going to show you some very interesting slide pictures. When you are viewing, I want you to move your eyes around so that you can be sure you can see all the details. Every time, a set of three slides will be presented to you successively. After you have viewed the first two slide pictures, the third one will be presented to you. When the third one is presented, I want you to tell me what you are viewing on it as quickly as possible."

The experiment began after the subject had understood the procedure. The exposure time for the first slide was 6 sec. After the first slide had disappeared for 4 sec., the second slide was presented for 5 sec. Then, the second slide was removed. The third slide was presented 4 sec. after the removal of the second slide and remained on the screen until the subject had finished his report.

Each subject was exposed to all six sets of 3 slide pictures. No suggestion was allowed in this stage. The experimenter observed and wrote down the subjects' responses.

2. Suggestion Stage:

The Suggestion Stage proceeded after the Non-suggestion Stage had ended. The procedures were all the same except that the instructions were different.

"Now, I am going to show you the slide pictures all over again. This time, however, I want you to view very carefully the third slide picture in each set to see if you can see on it anything which is the combination of the first slide and the second slide. If you see something on it, please tell me as quickly as possible. If not, please say, 'Nothing'."

(2) Test for "Dot Numbers"

The subject was seated 50 cm. away from the easel. The experimenter presented the first random-dot pattern (Figure 4, 1) to the subject by attaching it on the display-board. The exposure time was 2 minutes. (If the subject reported an eidetic image in less than 2 minutes, the first random-dot pattern was removed. However, the exposure time was at least 1 minute.) The subject was asked to move his eyes around so that he could see every dot on the pattern. When the first random-dot pattern was removed, the subject was asked if he saw anything on the easel. If no image or if only after image was reported, the experiment was terminated. However, if an eidetic image was reported, the second random-dot pattern (Figure 4, 2) was presented to the subject. The subject was to view it very carefully. He was then asked to superimpose the eidetic image of the first random-dot pattern on the second random-dot pattern at the top, making the rectangular borders coincide exactly. If he reported that he could see any

Arabic number appearing, he was asked to report. The experimenter wrote down the answer.

(3) Test for "Floating Figure"

The subject was seated 30 cm. away from the easel, with his right eye covered. The experimenter presented the left-eye pattern of the stereogram (Figure 5, L) by making use of the display-board. The subject was asked to examine and scan the left-eye pattern very carefully. After 2 minutes, the left-eye pattern was removed. (If the subject reported an eidetic image in less than 2 minutes, the left-eye pattern was also taken away. However, the exposure time was at least 1 minute.) The subject reported whether he could see any image on the easel. If no image or only the after image was reported, the experiment was terminated. However, if eidetic image was reported, the experimenter continued to present the right-eye pattern (Figure 5, R). And at the same time, the subject closed his left eye and opened his right eye to scan it. The exposure time was also 2 minutes. After that, the right-eye pattern was also removed. The subject reported whether he could see any image. If he reported seeing an eidetic image of the right-eye pattern, he also opened his left eye. Then, he was asked to visualize both the image of the left-eye pattern and the image of the right-eye pattern, and to make their rectangular borders coincide exactly. The subject reported whether he saw a figure floating off. If he saw this, he was also asked to write the figure on a sheet of paper.

(4) Test for "Spiral Aftereffect"

The subject was seated 100 cm. away from the easel. At the left side of the easel, about 45 degrees from the subject's direct line of vision, there was a color wheel with the spiral disk facing the subject. The stationary spiral was presented first to the subject by attaching it onto the display-board and resting the display-board on the ledge of the easel (see Figure 6). The subject was asked to scan it for one minute. After the removal of the stationary spiral, if the subject reported seeing no image, the experiment was terminated. If an eidetic image was reported by the subject, the experimenter started the motor of the color wheel by remote control. The subject then stared at the rotating-contracting spiral for one minute. Immediately afterward he shifted his gaze to the easel and called up the eidetic image of the stationary spiral. He was then asked to report what he saw on the gray surface of the easel. If he reported that the image of the stationary spiral seemed to expand, he was considered to have experienced the spiral aftereffect.

Results

(1) Test for "Combination Picture"

The number of times that the subjects reporting seeing a positive, composite image of the first slide picture and the second slide picture on the third slide were given in Table 23. Those who reported seeing a negative combination picture, a positive eidetic image of either the first slide or the second slide, and an image other than these were not included. An analysis of the data in this 2 x 2 contingency table by means of the Fisher's exact probability test yielded p = .030, which was statistically

Table 23. The Number of Times that the Subjects Reported Seeing a Combination Picture in the Third Slide

	Non-suggestion	Suggestion	Total
Eidetic Group	21	34	55
Non-Eidetic Group	0	8	8
	21	42	63

significant (Siegel, 1956, pp. 96-104). Inspection of the cell frequencies and the marginal totals revealed that (a) the frequencies of seeing a positive combination picture for the eidetic children were significantly greater than those for the non-eidetic children, (b) for the whole group, the occurrences of seeing a combination picture under the Suggestion Stage were significantly more frequent than those were under the Non-suggestion Stage, and (c) in either the Non-suggestion Stage or in the Suggestion Stage, the eidetic children reported seeing a combination picture more often than the non-eidetic children did.

(2) Test for "Dot Numbers", "Floating Figure", and "Spiral Aftereffect"

No subject in the Non-Eidetic Group had reported seeing the dot number "53", the floating figure "γ", or experiencing the spiral aftereffect. Therefore, only the data for the 30 eidetic children were analyzed. In the Test for Dot Numbers, 10 subjects successfully reported seeing the dot numbers "53", 4 subjects reported seeing "5" or "3"; 16 subjects failed. In the Test for the Floating Figure, only 4 subjects saw the figure "ɣ" floating toward them, 11 subjects saw the fragments of "ɣ" emerging in depth--but did not see the perfect "ɣ"; the remaining 15 subjects reported seeing nothing. In the Test for Spiral Aftereffect, 23 subjects reported seeing the image of the stationary spiral expanding; the others experienced contracting images or no image at all.

Discussion

(1) Test for "Combination Picture"

It was predicted in this experiment that the incidence of the composite eidetic images would be higher for the eidetic children than for the Non-Eidetic Group. The rationale was that because of the retarded erasure mechanism, an eidetic child may maintain his eidetic image of the first slide picture long enough to superimpose on the image of the second slide picture and then see an image of a combination picture on the third slide, which was in fact blank.

To see a combination picture in the third slide, the image of the first slide picture had to be maintained at least 13 sec., since 4 sec. after the removal of the first slide the second slide was presented for 5 sec., and the third slide was then presented 4 sec. after the removal of the second slide. Table 23 showed that this was a difficult task for the non-eidetic children to accomplish.

In the Non-suggestion Stage, none of the non-eidetic children reported seeing a combination picture on the third slide. On the other hand, whether they were in the Non-suggestion Stage or in the Suggestion Stage, the eidetic children reported seeing more combination pictures than did the non-eidetic children, the difference being statistically significant. Thus, Hypothesis 4 of the present study was positively supported.

There is an additional phenomenon worthy of our notice: The frequencies of reporting the images of a combination picture for both the eidetic children and the non-eidetic children increased after the suggestion was given by the experimenter, and after the subjects had some experiences in the Non-suggestion Stage. Apparently, an eidetic image can be affected by suggestion. This is not different from the fact that our perception of the external world can be influenced by our mental set. However, this does not mean that the conclusion Traxel (1962) had drawn is absolutely correct. In his study, Traxel concluded that so-called eidetic imagery when it is reported can be attributed to a combination of efficient retention, vivid memory images and suggestion (Richardson, 1969, p. 30). The same suggestion was given to both the eidetic children and the non-eidetic children, and yet the frequencies of seeing a combination picture were significantly lower for the non-eidetic children. Furthermore, even for the eidetic children, the "ability" to form a combination picture did not seem easy to obtain. In viewing the No. 5 slide set (Clown-face) of the present experiment, only 4 of the 17 eidetic children selected by the

"Strict Criteria" reported seeing a combination picture. In Haber's (1969) study, only 4 of his 20 eidetikers accomplished the same task (p. 44).

In a very few cases of the present study, the images of the first and the second slides became overlapped, one on the top of the other. In viewing the No. 2 slide set (83), for example, two of the eidetic children reported that they saw on the third slide an overlapped picture, "8" on the top of "3". Originally, it was expected that the overlapping would not occur, since the figure "8" was at the left of the first slide and the figure "3" was at the right of the second slide. However, the phenomenon of overlapping images did occur. Therefore, it is possible that under some other, even more complicated situations, the overlapping of eidetic images may occur more frequently.

(2) Test for "Dot Number", "Floating Figure", and "Spiral Aftereffect"

The three tests were modified from the tests developed by Stromeyer (1970). They indeed did not depend on verbal facility. The possibility that they could be biased by memory was therefore reduced. Thus, it was not easy to obtain scores in these tests unless the eidetic image was vivid and could be maintained for a relatively long time. The results of these tests showed that none of the non-eidetic children had ever been successful in any of these tests. As a matter of fact, all of them scored zero.

On each of the stimulus pictures for the Test of Dot Number, there were 101 dots randomly distributed in the rectangle (see Figure 4). Of the 30 eidetic children, 10 succeeded in superimposing the image of the first 101-dot-pattern on the top of the second 101-dot-pattern and reported the hidden figure "53". It seems impossible that they could accomplish this within 2 minutes without forming an eidetic image of almost photographic accuracy, since the dot patterns were designed in such a way that if most of the dots in the left and the right patterns did not coincide the figures "53" would not appear. Besides these 10 subjects who saw "53", there were 4 subjects who reported seeing either "5" or "3" appearing at the proper side of the rectangle. The chances that they would give the correct answers merely by guessing were 1/20, or p = .05. If the answer was correct it was significant. It was interesting to note that most of the eidetic children tried to adjust their eyes, or the distance between their eyes and the stimulus picture, so that the rectangular borders might coincide exactly. When memorizing, people do not behave that way.

The dots on the stimulus pictures for the Test of "Floating Figure" were even more numerous, more randomly distributed, and more difficult to be memorized. In addition, they are different in size. However, 4 of the eidetic children reported seeing the figure "と" floating off after they had combined the images of the left-eye pattern and the right-eye pattern. They accomplish this (i.e., experienced depth perception), without using a stereoscope. It was very impressive that these Chinese school children, who were not familiar with Japanese, could correctly write down the Japanese letter "と" by scanning their eidetic images. These cases provide us with strong evidence that eidetic imagery does exist. This does not mean that to be called an eidetiker, one must be able to see a floating figure without a stereoscope. It seems to me that the task assigned to the subjects in the present experiment was too difficult for the children of the age levels of the present study. [Stromeyer's subject was "a young teacher at Harvard, very intelligent, a skilled artist"] (1970, p. 77). Some subjects might have failed seeing the letter "T" just because they did not know the task assigned to them.

In the Test for Spiral Aftereffect, the subject must be able to call up the eidetic image of the stationary spiral after he had finished looking at the center of the rotating-contracting spiral. Otherwise, he would not be able to see the image of the stationary spiral expanding on the gray surface of the easel. Of the 30 eidetic children, 23 reported seeing the image of the stationary spiral expanding. This indicated that the eidetic image of the stationary spiral they experienced before they transferred their gazes to the rotating spiral was maintained long after they have finished looking at the rotating spiral, and was then influenced by their looking at the rotating spiral. Thus, the eidetic image may last over a relatively long period of time and be influenced by the behavior which occurred after that eidetic image. Accordingly, an eidetic image, if vivid and long-lasting, either can proactively affect behavior following it or can retroactively be influenced by the proceeding behavior.

Summary

Some techniques which had been developed by Haber (1969) and Stromeyer (1970) were modified and then applied by the present experimenter to test Hypothesis 4, "The incidences of the composite and the superimposed images for the eidetic subjects are significantly more frequent than those for the non-eidetic subjects." The evidence from the experiment consistently supported this hypothesis.

1. In the Test for "Combination Picture," the eidetic children could combine the image of the first slide picture and the image of the second slide picture and then see a combination picture on the third slide which was in fact blank.
2. Though the perception of the combination picture tended to be influenced by suggestions, the frequencies of seeing an image of combination picture for the eidetic children were consistently and significantly higher than those for the non-eidetic children.
3. In Test for "Dot Number," the eidetic children could superimpose the image of the first dot-pattern on the top of the second dot-pattern and thus see the hidden dot numbers. In the Test for "Floating Figure," the eidetic children combined the image of the left-eye pattern in their left eyes and the image of the right-eye pattern in their right eyes and then saw a figure floating in depth. They experienced depth perception without using a stereoscope.
4. In the Test for "Spiral Aftereffect," the eidetic children could call up the image of the stationary spiral after they had viewed the rotating-contracting spiral, and see the image of the

stationary spiral expanding. They experienced an apparent movement when the stationary spiral had in fact been removed.

5. The results of these observations showed that eidetic imagery does exist. They also showed that eidetic imagery may influence the behavior of the eidetic children.

EXPERIMENT 4

A COMPARISON OF ALPHA WAVE RECOVERY TIME BETWEEN THE EIDETIC AND NON-EIDETIC GROUPS

In 1935, Jasper and Carmichael stated that sometimes the potential rhythm of alpha waves did not reappear after stimulation in its pre-stimulation regularity and suggested tentatively that this latency period in the return to normal of the alpha waves was possibly associated with the phenomenon of the visual after-image. Jasper and Cruikshank (1937) undertook an experiment to test this hypothesis and showed that the exposure of a lighted red cross to a normal human subject who was placed in a dark room with his eyes open had effects upon the brain potentials from the occipital region of the head. They found that during the presence of a negative after-image, there always was a continued blocking of the alpha rhythm (p. 43). In 1943, Golla, Hutton, and Grey Walter suggested that people who make great use of visual imagery all the time are also likely to make greater use of their visual association area than those in whom the visual imagery is less customary or less vivid. This type of subject would be expected to have a small alpha rhythm even in the most placid conditions. As a working hypothesis they assumed that alpha records fell into three main groups:

1. "M" Type: Those with an extremely small alpha rhythm (below 10 microvolts maximum), and therefore the effect of opening and closing the eyes or of any such stimulus is invisible on the record.
2. "R" Type: Those with a clearly visible rhythm of the usual size (from 10 - 50 microvolts) when the eyes are shut, but which

is blocked or greatly attenuated either by opening the eyes or by vigorous mental exertion.

3. "P" Type: Those in which an alpha rhythm of average size is present to an equal extent at all times, whether the eyes are open or shut, and irrespective of the degree of mental activity of the subject (p. 219).

The results of their experiment showed that there was a close relationship between <u>alpha types</u> and <u>imagery types</u>. The M type of alpha rhythm tended to associate with the habitual visualizer; the P type, with the habitual verbalizer; and the R type, with both visual perception and visual imagery (pp. 220-221).

Later, Short (1953) replicated the experiment of Golla, et al. (1943), and confirmed the relationship between alpha types and imagery types as Golla, et al. had asserted (pp. 46-48).

On the other hand, Barratt (1956) also undertook an experiment to test the hypothesis that the amplitude of the alpha rhythm provides a reliable, objective index of visual imagery but did not find support for the hypothesis. The results indicated that although image-provoking problem situations reduced the amplitude of the alpha rhythm, the converse proposition that amplitude reduction is a measure of visual imaging was not confirmed (p. 113), since "imagery" appears to be only one of the many factors that may produce suppression effects (p. 101). Drever (1955), using blind persons as his subjects, also did an experiment to test the hypothesis that the behavior of the alpha rhythm is related to the kind of imagery used by different subjects, and that the disappearance of the alpha rhythm during mental exertion is associated with the use of visual imagery. Negative evidence was obtained, since he found that most of the subjects who had the EEG records of the typical visualizers' were in fact blind (p. 96).

Thus, it seems clear that there are many factors which may affect the alpha wave. Walter and Yeager (1956) also agreed that alpha suppression is not the result of sensory stimulation alone, but that it is also influenced by the degree of attention given to the stimulus (p. 193). Costello and McGregor (1957) believed that the amount of suppression of the alpha rhythm is a result of at least two factors, namely, the vividness of the image and the higher thought processes (p. 793). Oswald (1957) also found that the same individual may exhibit different types of EEG record on different occasions, and that the presence of a static or changing visual image was not accompanied by desynchronization of the alpha rhythm provided that the person concerned was not experiencing difficulty in achieving that image (p. 117). Slatter (1960) noticed that if the task was difficult, or especially if the task gave the impression of being a test of intelligence, alpha activity would be blocked non-specifically by anxiety (p. 858). The experiments by Kamiya and Zeitlin (1963), and Kamiya (1967) showed that alpha suppression could be voluntarily controlled by a subject when he had learned that the controlling stimulus was his own visual imagery. They also showed that the subject could be trained to choose correctly whether the alpha rhythm was present (A state) or absent (B state). Many of the subjects in these experiments reported that the presence of any sort of visual image was associated with the "B state" (Krech, et al., 1969; Richardson, 1969, p. 67).

From the studies reviewed above we know that imagery is one of the factors which affect alpha waves. Thus, the present experimenter hypothesized that the relationship between eidetic imagery and the suppression of alpha waves was even closer than that between after imagery and the suppression of the alpha waves.

Given that visual imagery results in a suppression of alpha wave, then recordings of alpha wave provide another test of Travers' assumption. The rationale, briefly, is that the presentation of a visual stimulus will result in the suppression of alpha wave among both eidetikers and non-eidetikers. But if the visual image persists beyond the termination of the stimulus for the eidetiker, then the reoccurrence of alpha waves will be delayed comensurately. As long as the eidetic imagery is active, the alpha waves will be affected. On account of this underlying rationale, Hypothesis 5 is that "In an EEG test, the post-stimulation alpha recovery time for the eidetic subjects is significantly longer than that for the non-eidetic subjects." This hypothesis was tested in the present experiment.

Method

Subjects. Subjects were the same 30 eidetic children and the same 30 non-eidetic children who had participated in Experiment 3.

Apparatus. The set-up in the present study included an eight-channel electroencephalograph (Type T, Offner Co.), a tachistoscope (Mishima Mfg. Co.), a transformer, a marker, a signal key, a decade interval timer (Model III-C, Series D, Hunter Co.), a dry battery, a pair of interphone, and a tape recorder.

The electroencephalograph, the main amplifying and recording system, was used to pick up the electroencephalogram (EEG). The tachistoscope was used to present the stimulus picture to the subject. The stimulus picture was an 18 cm. x 18 cm. colored picture placed on a frosted glass panel of a light tight box of the tachistoscope illuminated by two 40 W. electric lights. The intensity of the light source was maintained almost constant by adjusting the transformer to 80 Volts. When the electric lights were on, the picture could be seen by the subjects through the one-way glass between the dark room where the subjects were seated and the control room where the experimenter was manipulating the recording apparatus.

Procedure. The subject was seated in a semi-sound-proof and electrically shielded dark room, 100 cm. in front of the one-way glass. He was instructed to sit quietly in a position as completely relaxed as possible. Scalp electrodes were unilaterally applied to the frontal, the central, the parietal, and the occipital area of his right hemisphere by using a bipolar recording technique. Thus, only 3 of the 8 channels were used. The first channel might pick up the EEG between the frontal area and the central area, and sometimes the eye movements of the subject. The second chan nel might pick up the EEG between the central area and the parietal area. The third channel might pick up the EEG between the parietal area and the occipital area, that is, the visual area. The apparatus was adjusted in such a way that the recording paper would run 3 cm. per second, that a calibration of 8 mm. represented an amplitude of 50 μV., and that the exposure time of the stimulus picture was exactly 30 sec. During the experiment, the instructions of the experimenter were transmitted to the subject in the dark-room through an interphone. The subject's voice was transmitted to the experimenter in the control room through a microphone and was also recorded by a tape recorder.

The experiment was undertaken in the following three session, each with three periods.

(1) Recovery-Time Session

1. Pre-Stimulation Period

Routine resting records were taken both with the eyes open and with the eyes closed for three minutes, each at least three times, during the Pre-stimulation Period. The purposes of these trial runs were to observe the effects of the eye-opening and the eye-shutting on the subject's EEG and to establish some basic measures for each subject with which the measures obtained in other periods might be compared. One of these basic measures was "pre-stimulation recovery time" (see Figure 9).

2. Stimulation Period

During the last trial run of the Pre-stimulation Period, the eyes of the subject were closed. When the Stimulation Period began, the experimenter said, "Eyes open," and at the same time, started the interval timer to present the stimulus picture to the subject. The marker would mark a signal on the recording paper to show the beginning of the exposure time (see Figure 7). The subject was asked to move his eyes around to scan every detail of the stimulus

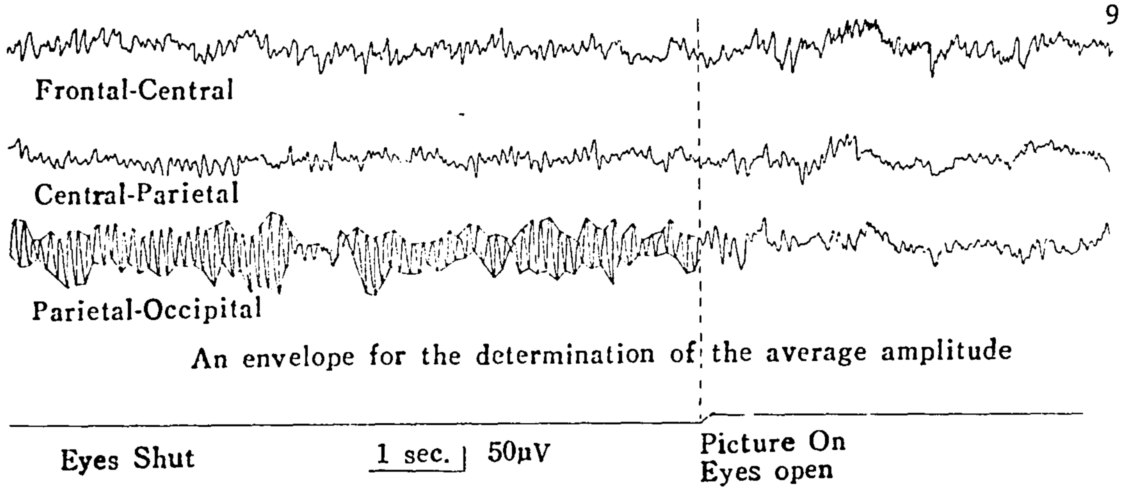


Figure 7. The Determination of the Average Amplitude. An envelope was drawn by connecting the peaks of the occipital electrical activity, as it was done in the third channel. With a ruler calibrated in cms., the peak to peak amplitude at each of the one-fifth second lines for 10 sec. was measured.

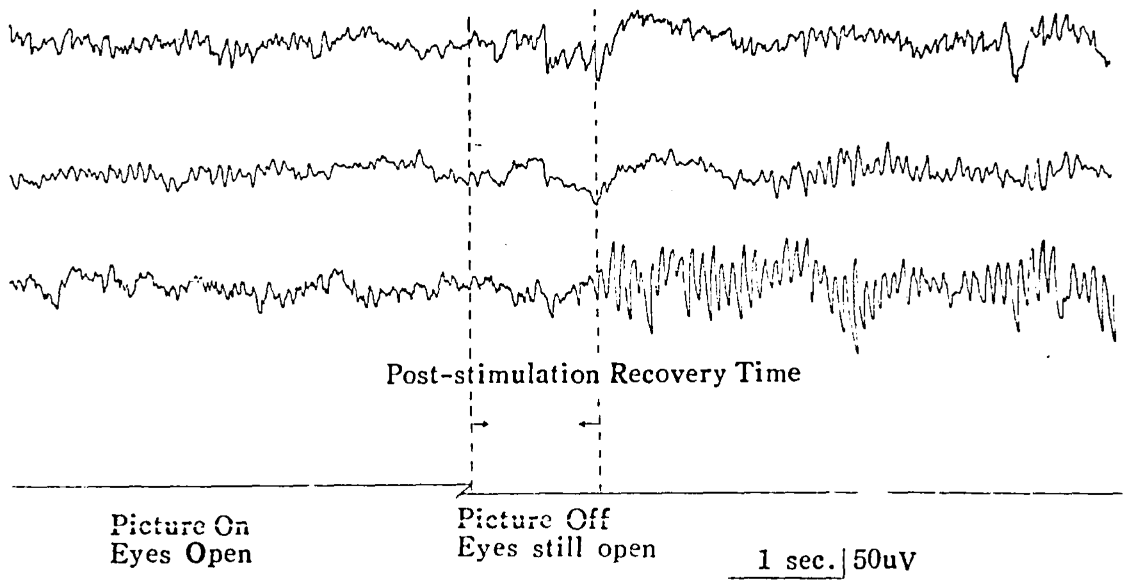


Figure 8. The Determination of the "Post-Stimulation Recovery Time." Post-stimulation recovery time was defined as the time from the cessation of the stimulus picture (left arrow) to the first appearance of the alpha rhythm (right arrow) in the Post-stimulation Period.

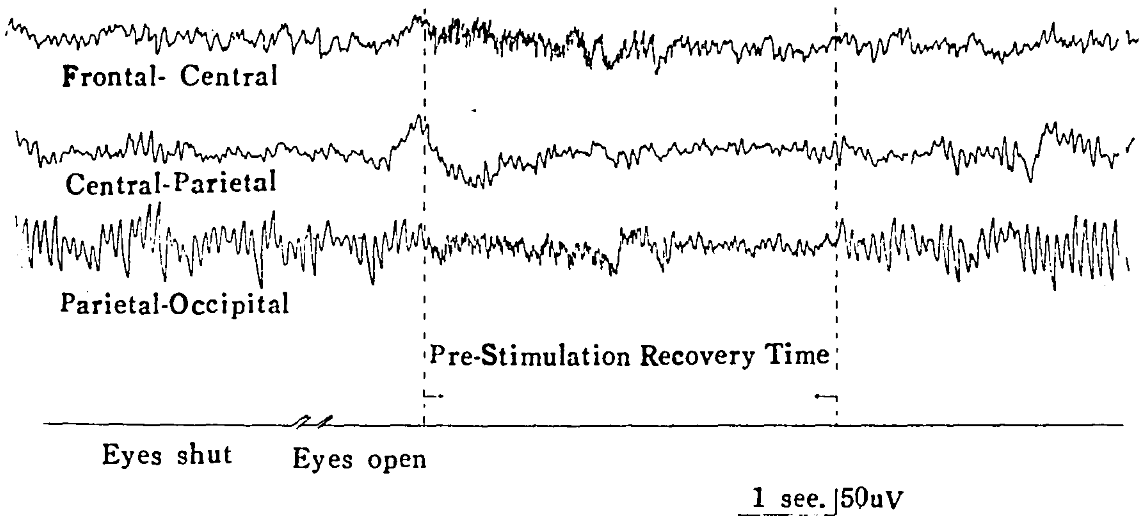


Figure 9. The Determination of the "Pre-Stimulation Recovery Time." Pre-stimulation recovery time was defined as the time from the first suppression of alpha wave (left arrow) to the first appearance of alpha wave (right arrow) in the Pre-stimulation Period.

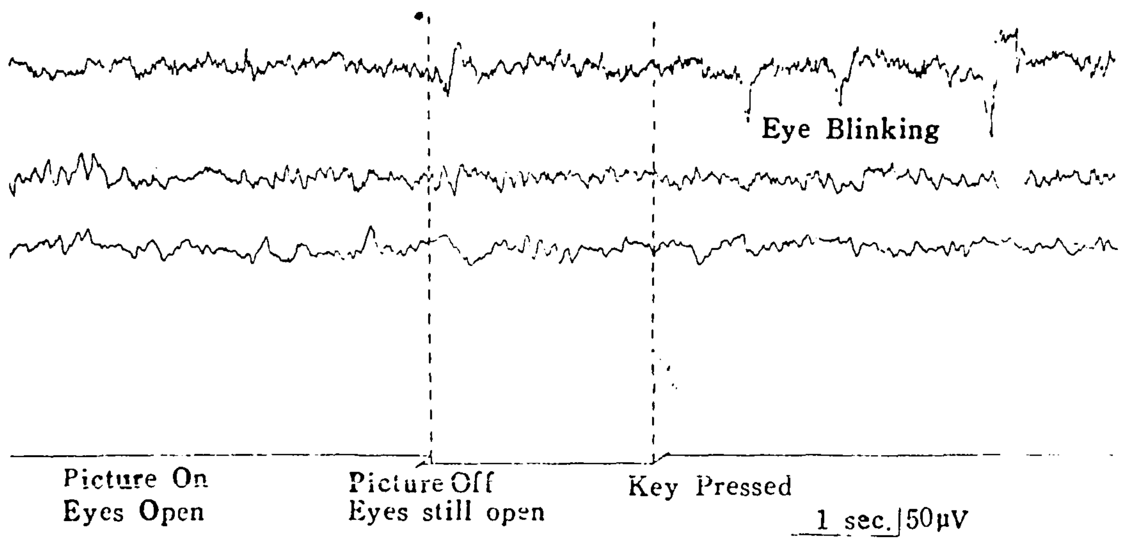


Figure 10. An Example of EEG Recording in the Key-Pressing Session. The subject was instructed to press a telegraph key if he saw any image after the removal of stimulus picture.

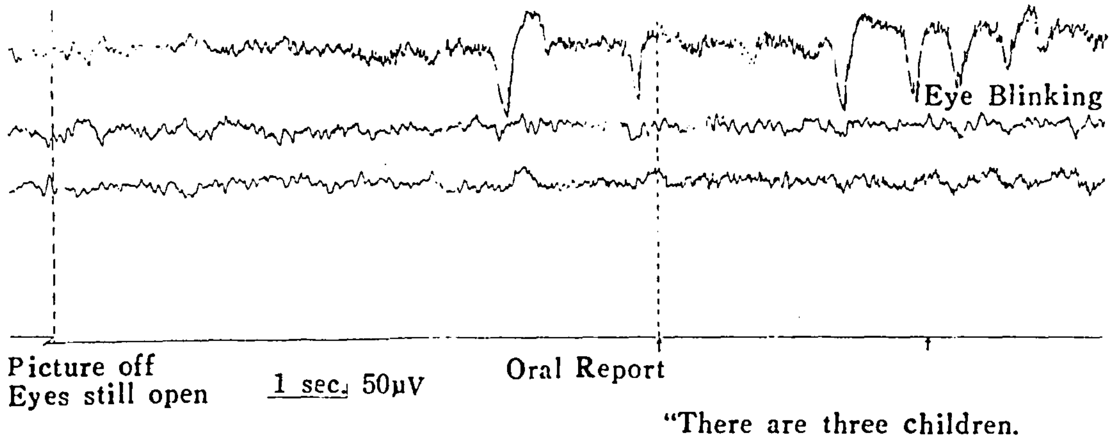


Figure 11. An Example of EEG Recording in the Oral-Report Session. The subject was instructed to report orally if he saw any image after the removal of the stimulus picture. Note the eye blinkings in the first channel.

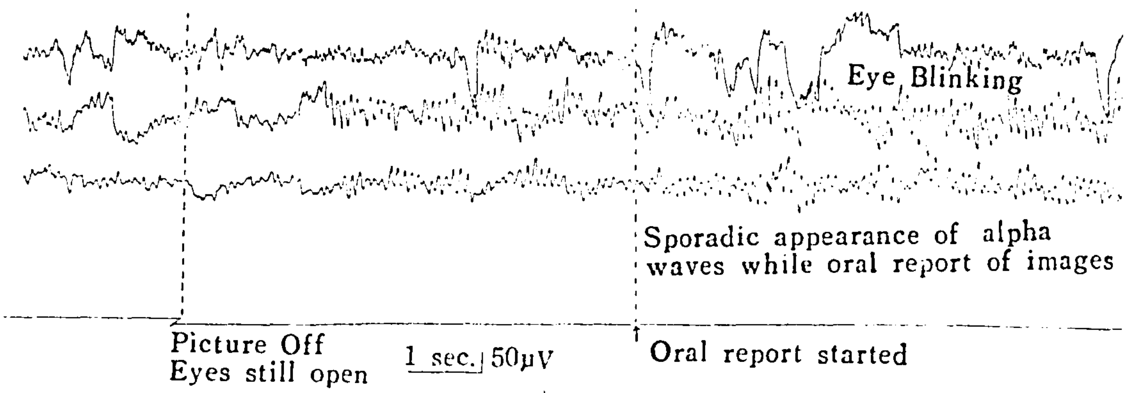


Figure 12. A Part of the EEG Recording of the Subject E20, an Eidetic Child, in the Oral-Report Session. Alpha waves may appear even when the subject is reporting seeing eidetic images.

picture which was projected through the one way glass from the tachistoscope in the control room.

3. Post-stimulation Period

The stimulus picture would disappear 30 sec. later. The marker would mark a signal on the record. The subject continued to look around where the stimulus picture had been, to see if he could see anything there. He was not asked to do anything beyond this. The experimenter paid special attention to the EEG record to see if the alpha rhythm had reappeared after the removal of the stimulus picture. A measure to be obtained here was "post-stimulation recovery time" (see Figure 8). Three or five minutes later, the subject was asked to close his eyes again. One or two minutes later, this session was terminated.

(2) Key-Pressing Session

The second session began after the subject had taken a rest for 5 minutes. The subject's signal key was put on the right arm of the subject's chair. The experimenter began to give instructions and help the subject to take preliminary training so that the subject might understand how and when to press the key. The subject was asked to move his eyes around to see if he could see something after the stimulus picture had been removed. He pressed the telegraph key immediately when he saw any image and held it down during the presence of the image, releasing it for the intervening intervals. When the subject pressed the key, the marker would record a signal on the recording paper along with the EEG (see Figure 10).

After the preliminary training, the experiment proper began. The procedures were the same as those used in the first session, except that the subject indicated the appearance of an image by pressing the signal key. At the end of this session, the experimenter wrote down the subject's report of introspection.

(3) Oral-Report Session

The third session began after the subject had taken a rest for 5 minutes. The signal key was removed away from the subject. The experimenter checked the functioning of the microphone and tape recorder and then gave instructions. In this session, however, the subject was asked to report orally when he saw image appearing after the removal of the stimulus picture (see Figure 11). It was essential that the subjects report the details and the colors as clearly as possible The experiment started after the subject had understood the method. The procedures were the same as those in the first and the second sessions, except that the subject in this session had to report orally.

The subject's oral report was transmitted to the control room and was recorded by a tape recorder. After the experiment, the EEG record and the taped oral record were played synchronously again so that the EEG record could be compared with the oral report, in the hope of discovering relationship between the two records.

Results

(1) Imagery Groups and Alpha Types

All EEG records of the two groups of subjects were analyzed and then classified into "M" type, "R" type, and "P" type, by using Golla, Hutton, and Grey Walter's (1943) definition. The results in Table 24 showed that only 2 of the 60 subjects had records of 'M' type, with no alpha-rhythms; none of the 60 subjects had records of 'P' type, with alpha-rhythms persistent; and 58 of the 60 subjects had records of 'R' type, responsive by suppression of the alpha-rhythm. No significant association between imagery groups, eidetic and non-eidetic, and alpha types could be found.

Table 24. Relation of Imagery Groups and Alpha Types

	'M' type	'R' type	'P' type
Eidetic Group	2	28	0
Non-Eidetic Group	0	30	0

(2) Resting Alpha Amplitudes and Resting Alpha Frequencies

In order to determine the mean resting alpha amplitude and the mean resting alpha frequency, the records obtained in the last closed-eye trial of the Pre-stimulation Period were analyzed by a technique used by Walter and Yeager (1956, p. 194). An envelope was drawn by connecting the peaks of the occipital electrical activity, as illustrated by the third channel recording in Figure 7. With a ruler calibrated in cms., the peak to peak amplitude at each of the one-fifth second lines for 10 sec. was measured. Thus 50 measures of the peak to peak amplitude were obtained and the mean amplitude in mms. was easily determined. The mean resting alpha frequency was obtained by dividing the total number of peaks by 10.

Results in Table 25 indicated that both the difference of the mean resting alpha frequencies and the difference of the mean alpha amplitudes were not statistically significant for the two groups of children ($ps > .05$). The two groups were equivalent before the stimulation was given, so far as the resting alpha frequency and alpha amplitude were concerned.

Table 25. The Mean Resting Frequencies and the Mean Resting Amplitudes for the Eidetic and Non-Eidetic Groups

	Mean Frequencies (c/s)		Mean Amplitudes (mm.)*	
Eidetic Group	M = 10.68	SD = 2.42	M = 6.53	SD = 2.50
Non-Eidetic Group	M = 10.08	SD = 0.74	M = 7.74	SD = 2.82
	t = 1.30		t = -1.76	

*8 mm. = 50 μV.

(3) A Comparison on "Post-stimulation Recovery Time"

According to Jasper and Cruikshank (1937), "the time from the cessation of the stimulus to the first appearance of the rhythm" was called "post-stimulation recovery time" (p. 39). In the present study, we also called the time from the cessation of the stimulus picture to the first appearance of the alpha rhythm in the Post-stimulation Period "post-stimulation recovery time" (see Figure 8). The post-stimulation recovery time of each subject was used as criterion in the analysis of covariance. Beside this, in the Pre-stimulation Period, the alpha wave would also be suppressed when the subject was asked to open his eyes following a trial with eyes closed. Therefore, in the last trial with eyes open, the time from the first suppression of alpha wave to the first appearance of it was called "pre-stimulation recovery time" (see Figure 9) and this served as the covariate in the analysis of covariance.

Table 26. The Analysis of Covariance on the Post-Stimulation Recovery Time for the Eidetic and Non-Eidetic Children

Sources	Adjusted Variation	df	MS	F
Between	441.06	1	441.06	17.07**
Within	1369.59	53	25.84	
Total	1810.65	54		

$^{**}F_{.99(1,60)} = 7.08$

Table 26 was based on the data of the 28 eidetic children and those of the 28 non-eidetic children. The data of the 2 eidetic children with 'M' type alpha rhythm and those of their counterparts, 2 non-eidetic children, were discarded. The variation of the post-stimulation recovery time for the two groups was highly significant, $F = 17.07$, $p < .001$, as shown in Table 26. The adjusted means of the post-stimulation recovery time for the eidetic children was

Table 27. Adjusted and Unadjusted Means of the Post-Stimulation Recovery Time for the Two Groups of Children

	Unadjusted Means		Adjusted Means
	Pre-S Recovery Time	Post-S Recovery Time	Post-S Recovery Time
Eidetic Group	$\overline{X}_E = 3.05$	$\overline{Y}_E = 9.30$	$\overline{Y}'_E = 9.63$
Non-eidetic Group	$\overline{X}_c = 2.56$	$\overline{Y}_c = 3.00$	$\overline{Y}'_c = 2.69$
	$t=.81$, n.s.	$t=4.12$, $p<.001$	

significantly longer than that of the non-eidetic children, as shown in Table 27. (Judging from unadjusted means, the post-stimulation recovery time is much longer for the eidetic children than that for the non-eidetic children, even if analysis of covariance were not applied.)

(4) A Comparison on "Post-Stimulation Alpha Index"

The percentages of alpha waves which appeared within the period from the cessation of the stimulus picture to the time 15 sec. after the cessation of the stimulus picture were calculated, and labeled the "post-stimulation alpha index." (The term "alpha index" had been used by Drewes, 1958.) The measures of the post-stimulation alpha index were used as criteria for analysis of covariance in Table 28. In addition, the percentages of alpha wave which appeared in the last eye-open trial of the Pre-stimulation Period were also calculated, and was labeled the "pre-stimulation alpha index." The measures of the pre-stimulation alpha index were used as covariates.

Table 28. The Analysis of Covariance on the Post-Stimulation Alpha Index for the Two Groups of Children

Source	Adjusted Variation	df	MS	F
Between	13879.61	1	13879.61	44.62**
Within	16485.51	53	311.04	
Total	30365.12	54		

$^{**}F_{.99}(1,60) = 7.08$

We see in Table 28 that the variation of the post-stimulation alpha index for the two groups of children was statistically significant, $F = 44.62$, $p < .01$. The results in Table 29 show that the adjusted mean of the post-stimulation alpha index for the eidetic children was significantly smaller than that for the non-eidetic children.

Table 29. Adjusted and Unadjusted Means of the Post-Stimulation Alpha Index for the Two Groups of Children (b = .52)

	Unadjusted Means		Adjusted Means
	Pre-S Alpha Index	Post-S Alpha Index	Post-S Alpha Index
Eidetic Group	$\overline{X}_E$ = 54.79%	$\overline{Y}_E$ = 29.32%	$\overline{Y}'_E$ = 27.22%
Non-eidetic Group	$\overline{X}_C$ = 62.89%	$\overline{Y}_C$ = 65.64%	$\overline{Y}'_C$ = 67.74%

(5) <u>The Responses in Key-Pressing Session and in Oral-Report Session</u>

A. <u>Key-pressing Session</u>: Of the 30 non-eidetic children, only 6 subjects pressed the telegraph key; the others did not press, indicating that they did not see any image after the cessation of the stimulus picture. The introspective reports after this session showed that the 6 subjects who pressed the telegraph key only saw after images. On the other hand, of the 30 eidetic children, only 4 subjects did not press the telegraph key; the other 26 eidetic children pressed the telegraph key. Introspective reports showed that the 26 eidetic children had seen the positive eidetic images. The mean key-pressing time for these 26 eidetic children was M = 50.17 sec. The deviation was large: SD = 98.83 sec., the longest being 469 sec., or 7 minutes and 49 sec.; the shortest being 3 sec.

B. <u>Oral-Report Session</u>: Of the 30 non-eidetic children, three subjects reported seeing images; the others reported seeing nothing. The taped records showed that these 3 subjects had seen after images. Of the 30 eidetic children, only 4 subjects reported seeing nothing; two subjects reported seeing after images; one subject's data could not be scored, due to malfunctions of the tape recorder. The tape recordings of the remaining 23 eidetic children showed that they had seen eidetic images. The mean duration of the eidetic images was M = 87.86 sec. The deviation was also large: SD = 96.25 sec., the longest being 449 sec., or 7 minutes and 29 sec.; the shortest, 22 sec.

(6) <u>A Comparison Among Recovery-Time, Key-Pressing Time, and Oral-Report Time</u>

The relationships among the post-stimulation recovery time, key-pressing time, and oral report time were also of interest. There were only 20 eidetic children whose data for the three measures were complete. In Table 30, only the data of these 20 subjects were used for analysis of variance. The data from those whose alpha rhythms were of 'M' type, who did not press the key, who reported seeing no images or seeing after images, and whose tape recording could not be scored were not included.

Table 30. The Analysis of Variance Among the Recovery-Time, the Key-Pressing Time, and the Oral-Report Time

Source of Variation	SS	df	MS	F
Between Subjects	237324.26	19		
Within Subjects	172511.73	40		
Sessions	51562.34	2	25781.17	8.10**
Residual	120949.39	38	3182.88	
Total	409835.99	59		

$^{**}F_{.99(2,38)} = 5.18$

The variation among the three measures was significant, F = 8.10, $p < .01$. As they were shown in Table 31, the mean post-stimulation recovery time was 10.0 sec., the mean key-pressing time was 47.2 sec., and the mean oral-report time was 81.8 sec. The Newman-Keuls test in Table 31 indicated that there was no significant difference between the mean key-pressing time and the mean oral-report time, $p > .05$. However, the mean key-pressing time was longer than the mean recovery-time, the difference was significant, $p < .05$; the mean oral-report time was also longer than the mean recovery-time, and the difference was highly significant, $p < .01$.

With the same data, some intercorrelations were calculated. The correlation coefficients between the recovery time and the key-pressing time was r = .13; between the recovery time and oral-report time, r = .19; both not significant. However, the correlation

Table 31. The Newman-Keuls Test Among the Recovery-Time, the Key-Pressing Time, and the Oral-Report Time (Sec.)

		Recovery Time	Key-Pressing Time	Oral-Report Time
	sec.	10.0	47.2	81.8
Recovery Time	10.0	--	37.2*	71.8**
Key-Pressing Time	47.2		--	34.6
Oral-Report Time	81.8			--

*p < .05 **p < .01

coefficient between the key-pressing time and the oral-report time was r = .97, (df = 18, t = 17.0, $p < .001$), which was significantly different from zero.

(7) A Comparison of Alpha Indices in Recovery-Time, Key-Pressing Time, and Oral-Report Time

The percentages of alpha waves within the post-stimulation recovery time, the key-pressing time, and the oral-report time were also calculated. The analysis of variance in Table 32 was also based upon the data of the same 20 eidetic children.

Table 32. The Analysis of Variance of Alpha Indices in the Recovery Time, the Key-Pressing Time, and the Oral-Report Time (%)

Source of Variation	SS	df	MS	F
Between Subjects	20062.31	19		
Within Subjects	12236.67	40		
Sessions	739.23	2	369.62	1.22
Residual	11497.44	38	302.56	
Total	32298.98	59		

The results in Table 32 show that the variation of alpha indices among the three measures was not significant, F = 1.22, $p > .05$. In other words, the mean alpha index in the recovery-time was M = 31%; that in the key-pressing time, M = 29%; that in the oral-report time, M = 37%. No significant difference was found between any two of these three mean percentage measures.

The correlation coefficients between the alpha index of the recovery time and that of the key-pressing time was $r = .25$; between the alpha index of the recovery time and that of the oral-report time, $r = .31$; both being not statistically significant. However, the correlation coefficient between the alpha index of the key-pressing time and that of the oral-pressing time was $r = .77$ ($df = 18$, $t = 5.12$, $p < .001$).

Discussion

(1) Comparisons Between Two Groups on Alpha Types, Frequencies, and Amplitudes

According to Golla, Hutton, and Gray Walter (1943), the 'M' type of alpha rhythm tends to associate with the habitual visualizer. Since an eidetiker may be thought of as a habitual visualizer, we may assume here that most of the EEG records of the eidetic children might belong to 'M' type, if Golla, et al.'s study was correct. However, the result in Table 24 showed that this was not supportable. Of the 30 eidetic children, only 2 subjects had alpha wave of 'M' type. All the other 28 eidetic children as well as the 30 non-eidetic children had alpha rhythms of 'R' type, that is, with amplitudes of usual size (10-50 μV.), present when the eyes are shut, and blocked or attenuated either by opening the eyes or by vigorous mental exertion. No significant association between imagery groups and alpha types was manifested. Thus, it is not possible to judge whether the subject is an eidetic or not from the subject's EEG.

(2) Testing Hypothesis 5

If Travers' (1970), and Golla, et al.'s (1943) are correct, one may further assume that because of the retarded development of the erasure mechanism, the eidetic children may have difficulty in erasing their vivid eidetic image, and as a result, the alpha rhythm will be suppressed for a relatively longer time. Therefore, it may be expected that the post-stimulation alpha recovery time of the eidetic children may be longer than that of the non-eidetic children. For this reason, an experiment was undertaken to test Hypothesis 5, "In an EEG test, the post-stimulation alpha recovery time for the eidetic subjects is significantly longer than that for the non-eidetic subjects."

Results of analysis of covariance in Table 26, using pre-stimulation recovery time as the covariate showed that the F for testing the significance of the adjusted between-groups variance was 17.07, which for the given df was significant at .01 level of significance. Inspection of Table 27 showed that the post-stimulation recovery time of the eidetic children was significantly longer than that of the non-eidetic children, $M = 9.63$ sec. for the former and $M = 2.69$ sec. for the latter. In other words, after the cessation of the stimulus picture, the alpha waves of the eidetic children were in average suppressed for 9.63 sec., while the alpha waves of the non-eidetic children were suppressed only for 2.69 sec.

Similar positive evidence also came from the results shown in Table 28. Testing the significance of the adjusted between-groups variance, resulted in an $F = 44.62$, $p < .01$. Inspection of Table 29 also indicates that the mean post-stimulation alpha index of the eidetic children was significantly smaller than that of the non-eidetic children, namely, M = 27.22% for the former and M = 67.74% for the latter. This points to the fact that within the 15 sec. period after the cessation of the stimulus picture, the incidence of alpha waves were only 27.22% for the eidetic children, while the incidence of alpha waves were as high as 67.74% for the non-eidetic children.

Evidence from the analysis of post-stimulation recovery time and post-stimulation alpha index positively supported Hypothesis 5 of the present study.

(3) Imagery Groups and Key-Pressing Responses

Jasper and Cruikshank (1937), in studying the relationship between after image and alpha rhythm, asked their subjects to press the key whenever they saw an after image. This method was found to be very effective. In the present study, the experimenter also wanted to know whether it is possible to express eidetic image by key-pressing, instead of by oral report. If the eidetic children tend to press the telegraph key and the non-eidetic children tend to not press it, it would be meaningful to ask a subject to press a telegraph key whenever he sees an image. Otherwise, it would be meaningless.

Table 33 showed that the eidetic children tended to press the telegraph key and the non-eidetic children tended not to press, C = .66. Since $\chi^2 = 45.66$ was highly significant, $p < .001$, the contingency coefficient was also highly significant. Therefore we may say with confidence that the key-pressing behavior is related to seeing an eidetic image, and that in the EEG experiment, it is proper to substitute the oral report by the key-pressing if the experimenter believes that the verbal facility might affect the result of the experiment.

Table 33. The Relationship of Imagery Groups and Key-Pressing Responses

	No Key-Pressing	Key-Pressing	
Eidetic Group	4	26	$\chi^2 = 45.88$
Non-eidetic Group	30	0	C = .66

(4) <u>A Comparison Among the Three Sessions of EEG Experiments</u>

Firstly, we may compare the subject's responses in terms of "time". Analysis of variance in Table 30 showed that the variation among "recovery time," "key-pressing time," and "oral-report time" was statistically significant, $F = 8.10$, $p < .01$. As they were shown in Table 31, the mean of the recovery time was 10.0 sec.; the mean of the key-pressing time was 47.2 sec.; and the mean of the oral-report time was 81.8 sec. The mean of the recovery-time was significantly shorter than both the mean of the key-pressing time ($p < .05$) and the mean of the oral-report time ($p < .01$).

Secondly, we may compare the subject's responses in terms of "alpha index." Analysis of variance in Table 32 showed that the variation of alpha indices in recovery-time, in key-pressing time, and in oral-report time was not significant, $F = 1.22$, $p > .05$. This meant that the mean alpha index in recovery-time (31%), the mean alpha index in key-pressing time (29%), and the mean alpha index in oral-report time (37%) did not differ significantly from one another.

Thirdly, we may also compare responses in terms of "correlation coefficients." Both the correlation coefficient between key-pressing time and oral-report time ($r = .97$), and the correlation coefficient between the alpha index in key-pressing time and the alpha index in oral-report time ($r = .77$) were statistically significant ($df = 18$, $ps < .001$). These results also supported what we have said above that it is proper to substitute an oral-report by key-pressing. On the other hand, the correlation coefficient between recovery time and key-pressing time ($r = .13$), between recovery time and oral-report time ($r = .19$), between the alpha index in recovery time and the alpha index in key-pressing time ($r = .25$), or between the alpha index in recovery time and the alpha index in oral-report time ($r = .31$), was not statistically different from zero. These facts indicated that perhaps it is not a good policy to use recovery time or alpha index in recovery time to predict the duration of an eidetic image.

(5) Eidetic Imagery and Alpha Rhythm

Results in Table 28 and Table 29 showed that there was a significant difference between eidetic children and non-eidetic children on the means of the post-stimulation alpha index. This meant that during the period 15 sec. after the withdrawal of the stimulus picture, the percentage of the appearance of alpha waves was lower for the Eidetic Group than that for the Non-Eidetic Group. This, however, did not necessarily mean that one may know whether or not the subject was experiencing an eidetic image by merely judging from his alpha index. Conceivably, the alpha rhythms might appear even when the subject was pressing the telegraph key or reporting seeing eidetic images (see Figure 12). A prominent case by the eidetic child, E 1, may be used as example. Of his 496 sec. of key-pressing time, alpha rhythms appeared for 351 sec. (75%). Of his 449 sec. oral report time, alpha rhythms appeared for 404 sec. (90%). The proposition that the appearance of an eidetic image is the cause of alpha suppression might not be correct. The relationship between eidetic imagery and alpha rhythms might in fact be a concomitant but not causal one.

Summary

An EEG experiment was undertaken to test Hypothesis 5, "In an EEG test, the post-stimulation alpha recovery time for the eidetic subjects is significantly longer than that for the non-eidetic subjects." This Hypothesis was proposed on the bases of Travers' (1970) assumption with regard to eidetic imagery and of Golla, et al. (1943)'s assertion concerning imagery types and alpha types. According to Travers, because of the retarded development of the erasure mechanism, an eidetic subject may see a vivid eidetic image after the cessation of the visual stimulus. According to Golla, et al., a habitual visualizer tends to have alpha rhythms that is responsible to mental exertion or to the image he experienced. Since an eidetic subject may be thought of as or habitual visualizer, his alpha rhythms might easily be affected by his eidetic image.

The results of the present experiment may be summarized as follows:

1. Golla, et al.'s claim that persons may be broadly classified into imagery types on the basis of their alpha types was not supported. If an eidetic subject may be thought of as a habitual visualizer, his alpha rhythm should belong to the 'M' type. However, almost all of the eidetic children in the present study had an EEG record of the 'R' type, instead of the 'M' type.
2. The post-stimulation recovery time for the eidetic children was significantly longer than that of the non-eidetic children. The post-stimulation alpha index for the eidetic dhilren was significantly smaller than that of the non-eidetic children. Hypothesis 5 was positively supported by experimental evidence.
3. When an eidetic subject was pressing a telegraph key or when he was reporting orally to show that he was experiencing an eidetic image, his alpha rhythms were not necessarily blocked. This indicated that the relation between the appearance of an eidetic image and the suppression of alpha rhythm was a concomitant rather than a causal relationship. One can not conclude that the appearance of an eidetic image is the cause of the alpha suppression, or that the alpha blocking is an objective index of the appearance of an eidetic image.
4. When an EEG experiment is undertaken to study the phenomenon of eidetic imagery, it might be a good policy to substitute the

oral report for key-pressing, if the experimenter suspects that the oral report may bias the experimental result.

Conclusion--Limitations of Travers' Assumption and a Tentative Model for Eidetic Phenomena

In this Chapter, four experiments were undertaken to test Hypotheses 2 to 5, which were deducted from Travers' assumption pertaining to the phenomenon of eidetic imagery. As mentioned before, if the hypotheses upon which the experiments were based are confirmed by the experimental evidence, then Travers' assumption may have more favorable empirical support. If the results of these experiments fail to support these hypotheses, then Travers' assumption would not be acceptable.

The underlying rationale for these four experiments was that because of a deficient erasure mechanism, images from antecedent stimuli continue to persist for a relatively long time and accumulate, overlap, or superimpose with the images or even the percepts of succeeding stimuli. All these may result in confusion, delay of response, or combination of images. The important results obtained from the present experiments may be summarized as follows: (1) The reaction time to the offset of the visual stimulus for the eidetic children was significantly longer than that for the non-eidetic children; and as the experiment progressed, the reaction time to the offset of the visual stimulus for the eidetic children became longer and longer. Hypothetically, this was due to the fact that as the images accumulate, the images become so vivid that the eidetic children had difficulty in responding to the incoming stimulus. (2) The search time for the absence of a target stimulus was significantly longer for the 17 eidetic children selected by the "Strict Criteria" than that for their counterparts, the 17 non-eidetic children. This was presumably because the accumulative images of the target stimuli looked similar to the percepts of the contex stimuli, and therefore confusions had occurred to the eidetic children. (3) The eidetic children demonstrated a persisting visual image in several ways: They reported a compound picture when two slide pictures were presented in sequence. They correctly identified figures that were "hidden" in sequentially presented dot-patterns. Also, they reported a stereoscopic effect when the left- and right-eye views were presented to the left and right eyes without the advantage of a stereoscope. Further, they reported the perception of an expanding spiral after viewing a rotating-contracting spiral while the stationary spiral had in fact been removed. (4) The post-stimulation recovery time of alpha waves was significantly longer among the eidetic children than among the non-eidetic children, presumably because an eidetiker's visual image persisted beyond the termination of the stimulus and the reoccurrence of alpha waves was delayed. All of these results lend positive support to Travers' assumption.

Although the present study tends to support Travers, there are findings that extend beyond expectation based on assumption of a deficient erasure mechanism. (1) In Experiment 2, the difference of search times for the absence of target stimuli between the 30 eidetic children selected by the "Less Strict Criteria" and the 30 non-eidetic children was not statistically significant. But, in the test for eidetic images, the eidetic images of the eidetic children persisted at least 30 sec. beyond the termination of the stimulus pictures. Therefore, in searching for the absence of target stimuli, the expected delay in search times would have occurred if only the erasure mechanism was functioning. The expected delay, however, did not occur. Thus, it is suspected that some kind of compensating mechanism might have functioned so that the effect of the deficient erasure mechanism was not manifested. Since the difference of search times for the 17 eidetic children selected by the "Strict Criteria" was significantly longer than that of the 17 non-eidetic children, it is possible that Travers' assumption of a deficient erasure mechanism may be applicable only for those children with "strong" eidetic images. (2) In the Test for "Spiral Aftereffect," the subjects were asked to view the stationary spiral first, then to view the rotating-contracting spiral, and then to call up the image of the stationary spiral. This meant that the subjects could to some extent control their eidetic images at will, that is, to banish them first and then to reproduce them. Thus, an eidetic image seemed erasable, or, at least, could be temporarily put aside and then be retrieved. In a special experiment arranged for him, the eidetic child, E 1, superimposed three images, one on the top of the others. But, he could take them apart or take the image which was covered at the bottom to the top of those images which had covered it. He also might on the basis of partial cues call up and scan the images of a distressing scene which he had seen from the TV news program several months ago. Travers' assumption of a deficient erasure mechanism can account for the persistence of an eidetic image, but it can not account for the phenomena mentioned here.

Accordingly, the phenomena associated with eidetic imagery proved to be more complex than which can be accounted for by the assumption of a deficient erasure mechanism. An explanation of all phenomena of eidetic imagery through the assumption of a deficient erasure mechanism will have limitations which must be carefully noticed.

A New Model for the Phenomena of Eidetic Imagery

Since Travers' assumption of a deficient erasure mechanism has its limitations, a new model for the phenomena of eidetic imagery is needed.

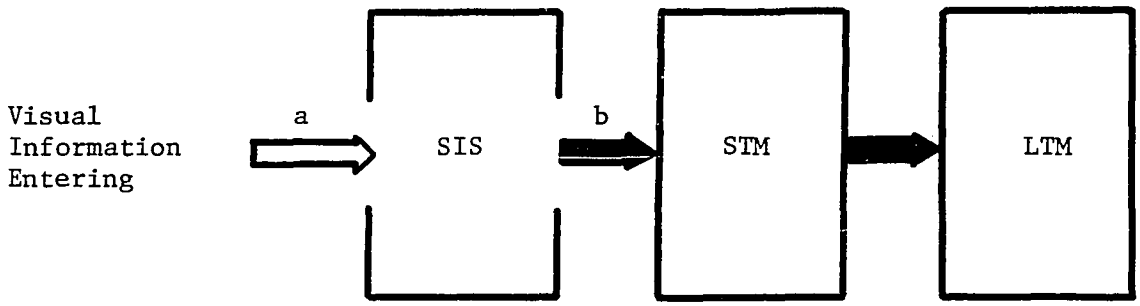
We may start the new model from the human information-processing theory. According to Norman (1970), "The general picture of human information processing is this. First, newly presented information would appear to transform by the sensory system into its physiological representation (which may already involve a substantial amount of processing on the initial sensory image), and this representation is stored briefly in a sensory information storage system. Following this sensory storage, the presented material is identified and encoded into a new format and retained temporarily in a different storage system, usually called short-term memory. Then, if extra attention is paid to the material, or if it is rehearsed frequently enough, or if it gets properly organized, the information is transferred to a more permanent memory system...." (p. 2). In short, there are three different stages of information storage system: a sensory information storage (SIS), a short-term memory (STM), and a long-term memory (LTM).

Usually, when the incoming visual information enters into the SIS, it is transformed by the visual system into its physiological representation, that is, into visual images, or iconic memory, as Neisser (1967) called it. After the information has been transferred to the short-term memory, the visual images will fade within a period ranging from several hundred msec. to about one sec. (Sperling, 1960). (See Figure 13, A.) However, it seems that a relatively longer duration of the visual storage may occur in case of an eidetiker. The visual information, in this case, remains in the SIS in the form of an eidetic image, iconic or unprocessed material. It does not decay very rapidly, neither is it encoded into a different format. (See Figure 13, B.) Our main concern here is "What happens with an eidetiker in SIS?"

Figure 13(A) illustrates the information-processing model for a non-eidetiker. The visual information enters into the SIS through the entrance and is temporarily stored in the SIS. The exit of the SIS for a non-eidetiker is usually as large as the entrance of the SIS, indicating that the channel capacity for the outgoing information (OC) is usually as large as the channel capacity for the incoming information (IC). Thus, the amount of information coming into the system (as shown by arrow a) usually does not exceed the outgoing capacity, OC. The processing of information is rapid and not delayed. A large amount of information can be rapidly encoded and transferred into the next stage (as shown by the arrow b).

Figure 13(B) illustrates the information-processing model for an eidetiker. The exit of the SIS for an eidetiker is relatively small as compared with the entrance of the SIS, indicating that the outgoing capacity (OC) is relatively smaller than the incoming capacity (IC). If the amount of information coming into the system does not exceed the capacity of the channel for outgoing information, there is no effect. However, if the amount of information is in excess of the capacity of the outgoing channel, the SIS will become "overloaded." Then, the processing of information will be delayed. The information in excess of the outgoing capacity will stay in the SIS, still in a form of iconic or unprocessed material. And this is an eidetic image.

(A) The Model for the Non-Eidetic Group



(B) The Model for the Eidetic Group

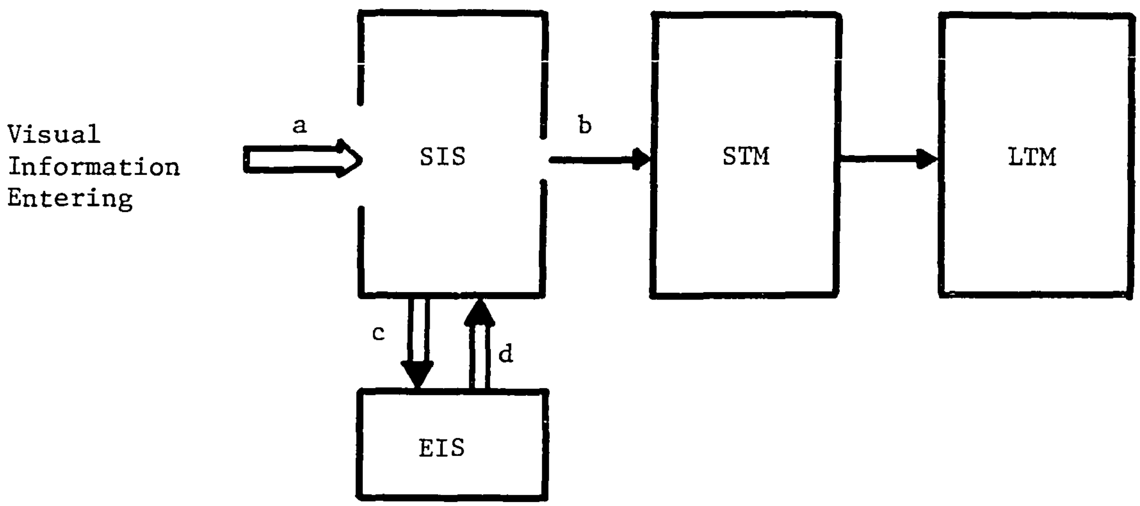


Figure 13. A New Model for the Phenomenon of Eidetic Imagery

SIS The sensory information storage
STM The short-term memory
LTM The long-term memory
EIS The eidetic information storage
<u>a</u> The incoming visual-information
<u>b</u> The outgoing encoded-information
<u>c</u> The stored eidetic-images
<u>d</u> The retrieved eidetic-images

Thus, we know that (1) whether an individual will be an eidetiker or a non-eidetiker depends upon the ratio of the incoming capacity to the outgoing capacity, or IC/OC ratio, and (2) whether the eidetiker does indeed become overloaded depends upon the amount of information entering the SIS.

Provided that the mean incoming capacities for the Eidetic and Non-Eidetic Groups are the same and that the amounts of the visual informations entering into the SIS are equal (as the present study had assumed), the mean outgoing capacity will be smaller for the Eidetic Group. That is, the information which is encoded into other format and transferred to the next stage is relatively small, and the information which is remained in the SIS is relatively large. Hence, the arrow b in Figure 13(B) is smaller than the arrow b in Figure 13(A). And, the mean IC/OC ratio of the Eidetic Group is larger than that of the Non-Eidetic Group. The larger the ratio, the stronger the disposition toward eidetic imagery. These statements imply that the eidetic images for the Eidetic Group will accumulate, interfere, superimpose, or overlap, while this will not occur in the Non-Eidetic Group. This was why all of the non-eidetic children failed to accomplish the tasks in Experiment 3, the tests of combination pictures.

Given that the IC/OC ratio for an eidetiker is fixed, the eidetiker does not necessarily become overloaded. When the amount, duration, and intensity of the incoming information is small, brief, and weak, the SIS will not become "overloaded" and thus the information can be processed very quickly. In Experiment 2, the subjects were asked to search for the absence of the target stimuli. No significant result was found between the Eidetic and Non-Eidetic Groups. In reading, people glanced very rapidly by fixating groups of words for very short interval of time (Travers, 1970, p. 49). Thus, the duration was brief even for the eidetic children selected by the "Less Strict Criteria." No effect was manifested for the 30 eidetic children as well as for the 30 non-eidetic children. In Experiment 1, however, there was difference between these two groups. The red light appeared for 3 to 5 sec. and the subjects were asked to respond to the offset of the red light. For the Eidetic Group, the amount of the incoming information was relatively large, perhaps in excess of the channel capacity of the outgoing information. And therefore, eidetic images accumulated to the extent that interference with the succeeding signals did occur.

In our new model for the eidetic phenomena, there is one special storage in addition to the SIS. We may call this storage the "Eidetic information storage," or EIS. In some cases, the accumulated images in the SIS may temporarily be stored in the EIS (as shown by the arrow c). Thus, for some eidetikers, the eidetic images can be banished, if necessary. The stored eidetic information may also be retrieved (as shown by the arrow d). Upon request, some eidetikers can call up their eidetic images. Since the information called up is still in the form of eidetic imagery, the encoding and decoding systems in EIS must be different from those found in the short-term and long-term storages. For those eidetikers who have the EIS, the phenomena of interferences between or among images or percepts do not necessarily occur.

It is clear that the new model can account for more aspects of the phenomena of eidetic imagery. However, it is by no means complete enough to account for all aspects of the eidetic phenomena. Further studies, quantitative and qualitative, are thus very needed.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

A sample of 519 subjects were randomly drawn from a population of 130,000 school children of Grades 3 to 6 in Taipei City. A method similar to that used by Haber and Haber (1964) was adopted to screen the eidetic children from this sample. Results indicated that if the "Strict Criteria," the same criteria used by the Habers, were used, 3.3% of the 519 subjects had been identified as eidetic children. By the "Less Strict Criteria," the percentage was 5.8%. The percentage found in the present study (3.3%) was significantly lower than that found in the Habers' study (8%). Both of these studies, however, revealed that the phenomenon of eidetic imagery was not a widely prevalent phenomenon.

Travers' assumption, which stated that eidetic imagery might be due to a retarded development of an *erasure mechanism*, was tested by undertaking four experiments using 30 eidetic children and 30 non-eidetic children as subjects. The rationale upon which these experiments were based was that because of a deficient *erasure mechanism*, images from antecedent stimuli continue to persist for a relatively long time and to accumulate, overlap, or superimpose with the images or even the percepts of succeeding stimuli. The following results were obtained: (1) The reaction time to the offset of the visual stimulus for the eidetic children was significantly longer than that for the non-eidetic children. (2) In the task requiring the subjects to search out the absence of target stimuli, the mean search time was not significantly different for the groups established by the "Less Strict Criteria," but eidetic subjects selected by the "Strict Criteria" required significantly more time in this task than their counterparts. (3) Some of the eidetic children demonstrated a persisting visual image in several ways. They reported a compound picture when two slide pictures were presented in sequence. They correctly identified figures that were "hidden" in sequentially presented dot-patterns. Also, they reported a stereoscopic effect when the left- and right-eye views were presented to the left and right eyes without the advantage of a stereoscope. Further, they reported the perception of an expanding spiral after viewing a rotating-contracting spiral while the stationary spiral had in fact been removed. (4) In EEG tests, the post-stimulation recovery time for the eidetic children was significantly longer than that for the non-eidetic children.

Evidence from these experiments tended to support Travers' assumption of a deficient erasure mechanism. There were, however, some findings that extended beyond expectation based on Travers' assumption. The phenomena of eidetic imagery proved to be more than what Travers' assumption of a deficient erasure mechanism can account for.

Recommendations

In closing this discussion, the writer wishes to stress the importance of the eidetic imagery to the welfare of the child who possesses it.

1. Psychologists interested in learning should be encouraged to study the phenomena of eidetic imagery from the viewpoint of learning theory. It is possible that eidetic imagery is one of the special "abilities" which were acquired according to learning principles in the individual's past history. It is well known

that early childhood experiences are likely to be encoded in visual modes, or in terms of the sensory qualities of the environment. If these experiences are reinforced according to the learning principles, the chances are good that the vivid eidetic image will persist into early childhood or into adult life. Thus, it is important to know how these experiences are reinforced in the developmental process of the eidetic individual. On the other hand, with an increase in age, the role of eidetic imagery begins to decline in a majority of children who live in modern industrialized societies. Thus, the persistence of vivid eidetic imagery into adult life is rare. This suggests that the imagery life which an eidetiker leads internally is no longer reinforced; it is under extinction, or even under punishment. For instance, if an eidetiker wrote his answers to the examination by scanning his eidetic images and were accused of cheating in the examination, this would be a punishing to him. And conceivably he would try to get rid of his eidetic images. Therefore, it is also important to know how an eidetic image declines in the eidetic child's developmental process.

2. Educators, teachers, and parents should be encouraged to study the phenomena of eidetic imagery from the viewpoint of education and guidance. Whether eidetic imagery is a "gift" or a "hindrance" to the eidetic child lies not so much in the child's own hands as in the hands of those who teach and direct him. It can be a gift, if an eidetic child is encouraged to use his eidetic

imagery in creative activities such as painting and problem solving. It is very impressive to observe an eidetic child combining two images and seeing floating figures in depth without using a stereoscope, or a child projecting an eidetic image on the top of an actual picture and seeing the "hidden" dot numbers. Apparently, the same "abilities" may be used in the creative activities mentioned above. Thus, for educational purposes, it is advisable that the characteristics of an eidetic child be kept alive and taken into account. Teachers and parents are responsible for discovering, encouraging, and guiding these eidetic children. On the other hand, eidetic imagery can be a source of difficulty or a hindrance to the child who possesses it. In some "strong" cases, visual interference may occur. As reported by some subjects in the present study, the interference may occur between the image of the first page and the percept of the second page in a textbook. It is possible that some of the underachievers in arithmetic or in reading might in fact be eidetic children. In performing educational guidance, teachers and parents should try to find and help these eidetic children. In addition, it is possible that eidetic imagery might influence the adjustive behaviors and the emotional states of the eidetic children. A child who mistakes his eidetic images for reality possibly may under some conditions manifest behavioral disorders. O'Neill (1933) mentioned a study in which a majority of eidetic girls in an institution were sex delinquents. Klüver (1931) also hoped that future investigations would bring out more clearly the significance of "criminalistic eidetic imagery" (p. 663). The eidetic subject E 1 in the present study might on the basis of partial cues call up a distressing scene which he had seen from TV news program. It is conceivable that he could become emotionally disturbed. So far, however, little attention has been given to cases like these. Behavioral and emotional guidance for eidetic children may be urgently needed.

3. Information scientists and cognitive psychologists should be encouraged to study the phenomena of eidetic imagery from their respective viewpoints. So far, no other information-processing model has been formulated to describe the phenomena of eidetic imagery. Perhaps a model like the one proposed here may be adopted for this purpose. As mentioned before, the information processing mechanisms in the SIS might be quite different for an eidetiker and for a non-eidetiker. For an eidetiker, the visual image stored in the SIS does not seem to be encoded into other type of codes very rapidly, as it normally should be. It seems that the eidetic images can be stored and even be retrieved, perhaps by means of a form quite different from what usually happens in the short-term and long-term memories. If this is correct, which one is more effective so far as information processing and cognitive processes are concerned? If more were known about these questions, it will be possible to indicate whether eidetic imagery is a "gift" or a "hindrance" to the eidetic child. Thus, further studies in this aspect is very

necessary and possibly very promising.

4. Physiologists and ophthalmologists should be encouraged to find out the physiological basis of eidetic imagery. It was Jaensch's (1930) belief that the T-type eidetic imagery has a physiological basis and that it can be diminished or extinguished by calcium feeding (pp. 30-31). He also reported that non-eidetic individuals produced eidetic images after taking mescalin (Richardson, 1969, p. 42). Perhaps Jaensch's observations were not entirely unfounded. So far, we still do not know whether an eidetic image is localized in the retina or in the central nervous system. If we knew, the disputation between the claim that an eidetic image is nothing but an after image (Morsh and Abbott, 1947) and the claim that an eidetic image is nothing but a memory image (Allport, 1928) might be resolved. Perhaps it will be very helpful if we can find an explanatory cause of eidetic imagery from the biochemical processes or, as Klein and Krech (1952) did, from the cortical satiation processes. When an eidetic child has the visual interference or confusion caused by eidetic imagery, it may be possible to have some specialists help him through knowledge of physiology, biochemistry, or ophthalmology.

APPENDICES

Appendix A. Data Sheet for Experiments of After Images, Eidetic Images, and Memory

_____EI School__________, Grade__________, Class__________.
_____NEI Name__________________, _________Boy______Girl,
_____IL Birthday:_____/ _____/ _____, Date:_____/ _____/ _____.

(1) After Image

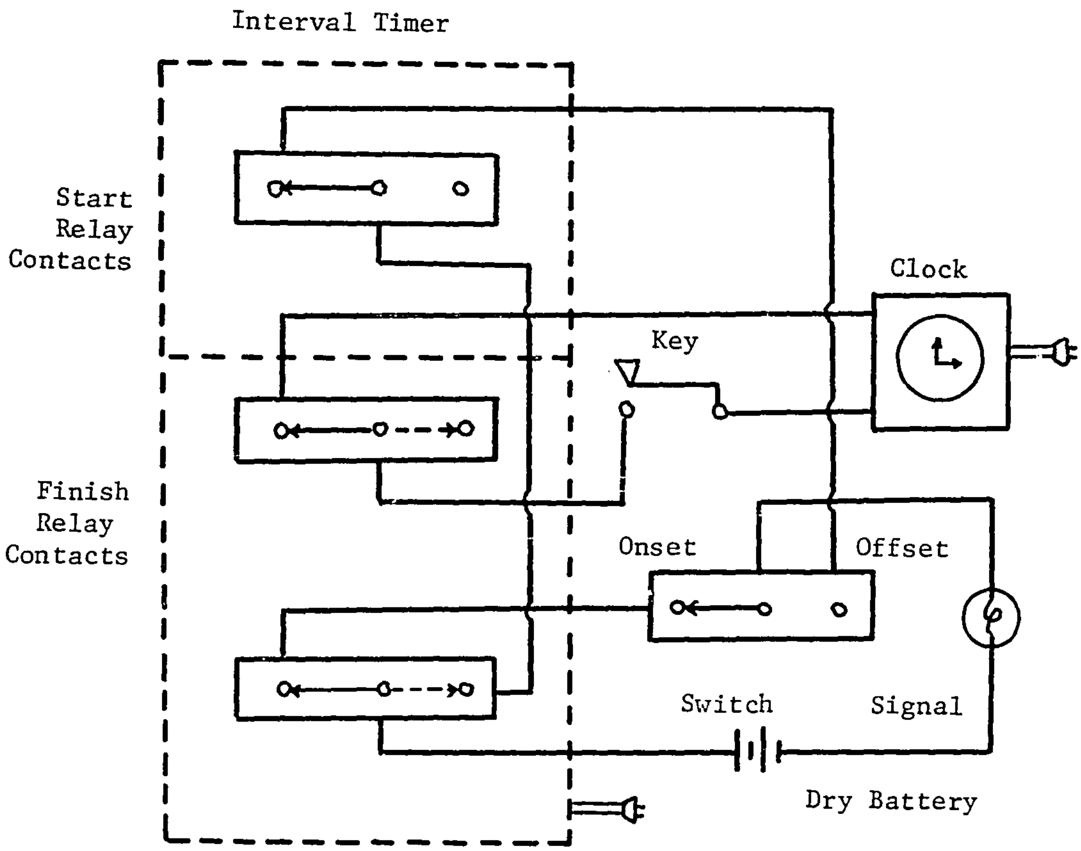
	Red	Blue	Black	Yellow
Image (Yes)(No)				
*Image (+) (-)				
Shape				
Movement (Yes)(No)				
*Duration (Sec.)				

(2) Eidetic Image

		Silhouette	Miscellania	Numeral	Kerchief	Gardening
Image (Yes)(No)						
	1					
	2					
	3					
	4					
*Details	5					
	6					
	7					
	8					
	9					
	1					
	2					
*Colors	3					
	4					
	5					
*Image (+) (-)						
Present Tense						
*Duration (Sec.)						
Location						
Eyes Movement						

(3) Memory

	1	2	3	4	5	6	7	8	9	10
* Detail:	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
	11	12	13	14	15	16	17	18	19	20
	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
	1	2	3	4	5	6	7	8	9	10
* Color:	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )



Appendix B. The Schematic of the Reaction Time Circuit

8	8	ㄌ	ㄌ	Q	Q
48157	56382	ㄈㄙㄌㄟㄚ	ㄞㄊㄉㄢㄌ	EIWXQ	UROQC
18475	36285	ㄚㄙㄈㄩㄌ	ㄎㄉㄞㄌㄊ	QIXEV	OGDUQ
14587	85632	ㄚㄌㄩㄟㄦ	ㄅㄉㄋㄞㄌ	WVIEQ	QGRCO
85174	26583	ㄑㄩㄌㄚㄟ	ㄞㄢㄉㄌㄊ	WIVQE	QDUOR
71534	36825	ㄟㄩㄈㄚㄌ	ㄉㄢㄎㄌㄞ	IXOWM	UQRDO
41857	83652	ㄈㄉㄩㄑㄚ	ㄋㄞㄊㄉㄌ	WIEXQ	QROUG
87514	93256	ㄚㄙㄦㄩㄌ	ㄅㄉㄊㄞㄋ	VEWQI	RGOUC
75418	82396	ㄈㄟㄑㄌㄙ	ㄉㄞㄌㄊㄢ	QMIVX	UGODQ
75814	26853	ㄙㄈㄦㄌㄚ	ㄎㄉㄋㄞㄌ	WMQEX	GDOQU
57481	85936	ㄩㄚㄑㄟㄌ	ㄋㄌㄅㄞㄉ	WMXIQ	DRCQO
51847	86935	ㄚㄩㄌㄑㄦ	ㄉㄎㄊㄌㄞ	XQ VEI	CODRQ
51487	58369	ㄑㄌㄙㄩㄚ	ㄞㄋㄊㄉㄌ	WM QEX	CUGQO
47851	59386	ㄙㄌㄈㄚㄑ	ㄉㄞㄋㄌㄅ	MEXMQ	QDOUC
17854	65938	ㄚㄟㄙㄈㄌ	ㄅㄞㄢㄉㄌ	XEVQM	UGOCQ
75481	59386	ㄦㄙㄈㄌㄑ	ㄋㄌㄞㄢㄉ	WMIXQ	CUQOD
47851	89563	ㄟㄈㄚㄌㄑ	ㄞㄋㄊㄉㄌ	MXEVQ	DOQGU
51784	93862	ㄌㄦㄈㄚㄙ	ㄉㄊㄌㄎㄞ	VIWQM	CQODG
71485	98536	ㄟㄙㄩㄚㄌ	ㄉㄅㄌㄢㄞ	EIQWV	GDROQ
57481	28639	ㄩㄈㄙㄌㄚ	ㄌㄅㄉㄞㄋ	EIMWQ	DCQOG
57841	63289	ㄌㄦㄈㄚㄙ	ㄉㄎㄌㄢㄞ	VMEWQ	COUQD
48715	26983	ㄩㄌㄙㄟㄦ	ㄌㄞㄢㄎㄉ	EQIM V	UDOQR
81475	82395	ㄑㄩㄌㄈㄦ	ㄌㄎㄢㄉㄋ	QWVI E	CUQDO
57418	96853	ㄙㄚㄈㄩㄌ	ㄎㄉㄅㄞㄌ	MQIVW	RUQDO
47185	36985	ㄟㄌㄚㄙㄈ	ㄅㄌㄢㄞㄉ	XVMQE	DRQGO
78541	83962	ㄚㄦㄌㄩㄑ	ㄉㄋㄞㄊㄌ	WIQMV	RQDOC
17845	63528	ㄦㄌㄩㄚㄙ	ㄉㄌㄎㄢㄞ	IEQVW	GODRQ
75148	59386	ㄚㄟㄌㄩㄙ	ㄊㄌㄞㄉㄋ	MWQEV	QCDOG
78541	59386	ㄈㄙㄑㄦㄌ	ㄊㄉㄌㄎㄞ	XEMVQ	URQGO
18457	68593	ㄩㄈㄟㄌㄑ	ㄉㄅㄢㄞㄌ	XWIQM	CUGOQ
84175	29368	ㄩㄈㄌㄙㄦ	ㄊㄌㄎㄉㄞ	XQVWE	RGCQO
14875	52683	ㄚㄌㄙㄈㄟ	ㄎㄞㄉㄊㄌ	MXIWQ	QUORD
87514	56893	ㄦㄚㄌㄙㄟ	ㄢㄞㄎㄉㄌ	IXVEQ	ROUDQ
51784	68359	ㄩㄦㄚㄑㄌ	ㄞㄢㄉㄌㄎ	VMEQX	ODQGU
51847	26398	ㄩㄙㄚㄌㄈ	ㄌㄞㄋㄊㄉ	WQXIV	ROGDQ
18754	83695	ㄌㄩㄑㄚㄦ	ㄉㄋㄊㄅㄌ	QXIVM	RQUCO
74581	65893	ㄦㄌㄩㄙㄈ	ㄊㄌㄢㄞㄉ	WMXIQ	ORQDU
47581	96382	ㄌㄦㄑㄚㄟ	ㄉㄎㄞㄢㄌ	XQMEW	OQCDG
48517	65839	ㄦㄈㄩㄚㄌ	ㄢㄎㄌㄉㄞ	IQMXE	UDGOC
14875	35826	ㄩㄈㄑㄌㄦ	ㄊㄋㄞㄉㄌ	XVEQM	RQDUO
84751	28563	ㄟㄌㄙㄚㄩ	ㄢㄉㄊㄌㄅ	IMQWE	DUOGQ
17458	82593	ㄈㄟㄌㄑㄩ	ㄋㄌㄉㄞㄢ	QX VEW	QURDO
48751	23865	ㄌㄚㄦㄙㄟ	ㄞㄉㄢㄊㄌ	QVEXI	RDQUO
57814	35698	ㄟㄌㄙㄈㄚ	ㄎㄢㄌㄉㄞ	VOEMI	OGRCQ
58471	63259	ㄙㄈㄌㄚㄑ	ㄋㄊㄞㄌㄉ	QXWMV	CDOGQ
74581	68539	ㄈㄌㄦㄟㄙ	ㄉㄞㄌㄎㄋ	XVIQM	DQROG
58147	36598	ㄌㄙㄈㄦㄟ	ㄉㄎㄅㄢㄌ	EQXIV	CRQDO
97345	69853	ㄦㄩㄈㄌㄙ	ㄅㄉㄞㄊㄋ	VIMWQ	RCQOD
74581	96853	ㄚㄈㄑㄟㄌ	ㄉㄎㄅㄢㄌ	MXIVQ	QDUOG
58147	95638	ㄟㄙㄌㄑㄩ	ㄢㄉㄊㄌㄞ	QWEXV	DCGOQ
57814	89236	ㄚㄩㄙㄌㄑ	ㄋㄊㄞㄌㄉ	IQWVX	GQORU
51874	96382	ㄈㄩㄉㄙㄟ	ㄎㄌㄉㄞㄢ	WMXQI	QDRUO
18547	96538	ㄌㄚㄈㄟㄩ	ㄌㄋㄉㄅㄞ	VXEWQ	DCRQO
17548	82365	ㄟㄙㄌㄦㄩ	ㄋㄅㄌㄞㄉ	VQMXE	RQGDO
71845	32568	ㄟㄌㄙㄈㄦ	ㄞㄅㄊㄉㄌ	EWMXQ	ROCUQ
84715	98235	ㄌㄟㄈㄦㄑ	ㄢㄋㄌㄉㄞ	WXIQE	QOURC
47158	36852	ㄚㄈㄙㄌㄟ	ㄞㄊㄢㄌㄉ	QWEIX	ODUCQ
75814	38526	ㄩㄙㄌㄦㄈ	ㄉㄞㄊㄎㄌ	XIVQE	CDORQ
47165	29683	ㄌㄑㄚㄦㄙ	ㄎㄌㄉㄅㄋ	WQEIX	OCQDR

Appendix C. Material for the Experiment on Search Time

BIBLIOGRAPHY

Adams, J. A. Human memory, New York: McGraw-Hill, 1967.

Allport, G. W. "Eidetic imagery," Brit. J. Psychol., 1924, 15, 100-120.

Allport, G. W. "The eidetic image and the after image," American Journal of Psychology, 1928, 40, 418-425.

Barber, T. X. "The 'eidetic image' and 'hallucinatory' behavior: A suggestion for further research," Psychol. Bull., 1959, 56, 236-239.

Barratt, P. E. "Use of EEG in the study of imagery," Brit. J. Psychol., 1956, 47, 101-114.

Bugelski, B. R. & D. A. Alam Pay. "The role of frequency in developing perceptual sets," Canad. J. Psychol., 1961, 15, 220-225.

Carmichael, L. "Eidetic imagery and the Binet test," J. Educ. Psychol., 1925, 16, 251-252.

Chen, C. C. Intelligence test for young children, Tainan: Kuang-tien, 1971.

Costello, C. G. & P. McGregor. "The relationship between some aspects of visual imagery and the alpha rhythm," J. Ment. Sci., 1957, 103, 786-795.

Doob, L. W. "Eidetic images among the Ibo," Ethnology, 1964, 3, 357-363.

Doob, L. W. "Exploring eidetic and other imagery among the Kamba of Central Kenya," J. Soc. Psychol., 1965, 67, 3-22.

Doob, L. W. "Eidetic imagery: a crosscultural will-o'-the-wish?" J. Psychol., 1966, 63, 13-34.

Drever, J. "Some observation on the occipital alpha rhythm," Quart. J. Exp. Psychol., 1955, 7, 91-7.

Drever, J. "Further observations on the relation between EEG and visual imagery," Amer. J. Psychol., 1958, 71, 270-276.

Drewes, H. W. An experimental study of the relationship between electroencephalographic imagery variables and perceptual-cognitive processes, Unpublished doctoral dissertation, Cornell Univ., 1958.

Dunn-Rankin, P. The similarity of lower-case letters of the English alphabet, Journal of verbal learning and verbal behavior, 1968, 7, 990-995.

Edwards, A. L. Statistical methods. (2nd ed.) New York: Holt, Rinehart & Winston, 1967.

Feldman, M. "Eidetic imagery in Ghana: A cross-cultural will-o'-the-wisp?" J. Psychol., 1968, 67, 259-269.

Fitts, P. M. & M. I. Posner. Human performance, Belmont, Calif.: Brooks/Cole, 1967.

Floyd, L. G. "Eidetic imagery in normal and psychotic cases: A study in the incidence and characteristics of eidetic imagery in normal and psychotic cases, and a comparative analysis of the groups," Dissertation Abstr., 1957, 17, 903.

Freides, D. & S. D. Hayden. "Monocular testing: A methodological note on eidetic imagery," Perceptual and Motor Skills, 1966, 23, 88.

Generelli, J. A. "Some quantitative experiments with eidetic imagery," Am. J. Psychol., 1930, 42, 399.

Gibson, E. J., H. Osser, W. Schiff & J. Smith. An analysis of critical features of letters tested by confusion. A Basic Research Program On Reading, Cooperative Research Project, No. 639. Ithaca: Cornell Univ., 1963.

Golla, F., E. L. Hutton, W. Gray Walter. "The objective study of mental imagery," J. Ment. Sci., 1943, 89, 216-223.

Haber, R. N. "Eidetic images," Scientific America, 1969, April, 220, No. 4, 36-44.

Haber, R. N. & R. B. Haber, "Eidetic imagery: I. Frequency," Percept. mot. Skills, 1964, 19, 131-138.

Haber, R. N. & M. Hershenson. "Effects of repeated brief exposures on the growth of a percept," J. exp. Psychol., 1965, 69, 40-46.

Hayashi, S. The eidetic imagery and the type of children, Trans. Inst. Child Stud. (Japanese), 1934, 16, 689-722.

Hayashi, S. "Chugakusei no Kaiga-dokokai-in niokeru chokkanzo ni tsuite," [On eidetic images in members of a picture-loving society in a middle school], Jap. J. appl. Psychol., 1936, 4, 168-170.

Hebb, D. O. "Concerning imagery," Psychol. Rev., 1968, 75, 466-477.

Holt, R. R. "Imagery: The return of the ostracized," Amer. Psychologist, 1964, 19, 254-264.

Jaensch, E. R. Eidetic imagery and typological methods of investigation, New York: Harcourt, 1930.

Jasper, H. H. & H. L. Andrews. "Human brain rhythms: I. Recording techniques and preliminary results," J. Gen. Psychol., 1936, 14, 98-126.

Jasper, H. H. & L. Carmichael. "Electrical potentials from the intact human brain," Science, 1935, 81, 51-53.

Jasper, H. H. & R. M. Cruickshank. "Electroencephalography, II. visual stimulation and the after-image as affecting the occipital alpha rhythm," J. Gen. Psychol., 1937, 17, 29-48.

Katz, G. G. "An investigation of eidetic imagery in conditions of hypoculcemia with and without latent tetany," Dissertation Abstr., 1957, 17, 889.

Klein, G. & D. Krech. "Cortical conductivity in the brain-injured," J. Pers., 1952, 21, 118-148.

Klemmer, E. T. "Simple reaction time as a function of time uncertainty," J. exp. Psychol., 1957, 54, 195-200.

Klüver, H. "Description of eidetic phenomena," Psychol. Bull., 1925, 22, 331.

Klüver, H. "An experimental study of the eidetic type," Genet. Psychol. Monogr., 1926, 1, 71-230.

Klüver, H. "Studies on the eidetic type and on eidetic imagery," Psychol. Bull., 1928, 25, 69-95.

Klüver, H. "Eidetic images," Encyc. Brit. (14th ed.), 1929, 8, 112.

Klüver, H. "Fragmentary eidetic imagery," Psychol. Rev., 1930, 37, 441-458.

Klüver, H. "The eidetic child," In C. Murchison (Ed.). A handbook of child psychology, Worcester, Mass.: Clark Univers. Press, 1931.

Klüver, H. "Eidetic phenomena," Psychol. Bull., 1932, 29, 181-203.

Krech, D. et al. Elements of psychology. (2nd ed.) New York: Alfred A. Knopf, 1969.

Lubin, A. "The interpretation of significant interaction," Educational and Psychological Measurement, 1961, 21, 807-817.

Lykken, D. T. "Statistical significance in psychological research," Psychol. Bull., 1968, 70, 151-159.

Mckellar, P. Imagination and thinking. New York: Basic Books, 1957.

McNemar, Q. Psychological statistics. (3rd ed.) New York: John Wiley & Sons, 1962.

Meenes, M. "Eidetic phenomena in Negro school children," Psychol. Bull., 1933, 30, 688-689.

Meenes, M. "The relationship of the eidetic phenomenon to the after-image and to the memory image," Psychol. Bull., 1934, 31, 739.

Meenes, M. & M. A. Monton. "Characteristics of the eidetic phenomenon," J. Gen. Psychol., 1936, 14, 370-391.

Michael, L. I. "A Factor analysis of mental imagery," Dissertation Abstr., 1967, 27(11-A), 3761.

Miller, E. "The affective nature of illusion and hallucination. Part II: Eidetic imagery," J. Neur. & Psychopathol., 1931, 21, 1-13.

Miller, G. A. "The magical number seven, plus or minus two: Some limits on our capacity for processing information," Psychol. Rev., 1956, 63, 81-97.

Morgan, C. T. Physiological psychology. (3rd ed.) New York: McGraw-Hill, 1965.

Morsh, J. E. "Further investigation of eidetic imagery," Psychol. Bull., 1942, 39, 611.

Morsh, J. E. & H. D. Abott. "An investigation of after-images," J. Comp. Psychol., 1945, 38, 47-63.

Neisser, D. Cognitive psychology, New York: Appleton-Century-Crofts, 1967.

Nickols, J. "Eidetic imagery synthesis," American Journal of Psychotherapy, 1962, 16(1), 76-82.

Norman, D. A. (ed.) Models of Human Memory. New York: Academic Press, 1970.

Norman, D. A. "Acquisition and retention in short-term memory," J. exp. Psychol., 1966, 72, 369-381.

Ohwaki, Y., et al. "Psychologisch-medizinische Undersuchung der eidetischen Anlage japanischer Jugendlicher," [Psychomedical investigation on the eidetic disposition among Japanese children] Tohoku Psychol. Folia, 1934, 2, 57-128.

Ohwaki, Y. Gakudo no tyokkanzo. [Eidetic imagery of school children] Tokyo: Toen-Syobo, 1936.

O'Neill, H. E. Eidetic ability: A detailed study of twenty-three eidetikers, Unpublished doctoral dissertation, The Catholic University of America, Washington, D. C., 1933.

O'Neill, H. E. & J. E. Rauth. "Eidetic imagery," Catholic Univ. America, Dept. of Education, Educ. Res. Bull., 1934, 8.

Oswald, I. "The EEG, visual imagery and attention," Quart. J. exp. Psychol., 1957, 9, 113-118.

Peck, I. & A. B. Hodges. "A study of racial differences in eidetic imagery of preschool children," J. Genetic Psychol., 1937, 51, 141-161.

Peck, L. & R. Walling. "A preliminary study of the eidetic imagery of preschool children," J. Genet. Psychol., 1935, 47, 168-192.

Penfield, W. "Interpretive cortex," Science, 1959, 129, 1719-1725.

Pierro, P. S. "An investigation of visual form perception and eidetic imagery in students who read well and spell poorly," Dissertation Abstracts, 1967, 27(9-A), 2894-2895.

Popp, H. M. "Visual discrimination of alphabet letters," Reading Teacher, January 1964, 17, 221-225.

Purdy, D. M. "Eidetic imagery and plasticity of perception," J. gen. Psychol., 1936, 15, 437-453.

Rauth, J. E. & J. J. Sinott. "A new eidetic phenomenon," Child Developm., 1937, 8, 112-113.

Richardson, A. Mental imagery. New York: Springer, 1969.

Saltzman, S. S. & S. Machover. "An inquiry into eidetic imagery with particular reference to visual hallucinations," Amer. J. Psychiat., 1952, 108, 740-748.

Sheehan, P. W. "Visual imagery and the organizational properties of perceived stimuli," Brit. J. Psychol., 1967, 58, 247-252.

Sheehan, P. W. "Color response to the TAT: An instance of eidetic imagery?" J. Psychol., 1968, 68, 203-209.

Sheehan, P. W. & U. Neisser. "Some variables affecting the vividness of imagery in recall," Brit. J. of Psychol., 1969, 60, 71-80.

Short, P. L. "The objective study of mental imagery," Brit. J. Psychol., 1953, 44, 38-51.

Siegel, S. Nonparametric statistics, New York: McGraw-Hill, 1956.

Siipola, E. M. & S. D. Hayden. "Exploring eidetic imagery among the retarded," Percept. mot. Skills, 1965, 21, 275-286.

Simpson, H. M., et al. "Occipital alpha activity of high and low visual imagery during problem solving," Psychonomic Science, 1967, 8, 49-50.

Slater, K. H. "Alpha rhythms and mental imagery," EEG clin. Neurophysiol., 1960, 12, 851-859.

Sperling, G. "The information available in brief visual presentations," Psychol. Monogr., 1960, 74, No. 11 (Whole No. 498).

Sperling, G. "A model for visual memory tasks," Hum. Factors, 1963, 5, 19-31.

Spitz, H. H. "The present status of the Kohler-Wallach theory of satiation," Psychol. Bull., 1958, 55, 1-29.

Stanley, G. & J. J. Furedy. "Size constancy and Emmert's law of apparent sizes," Australian J. Psychol., 1966, 18, 266-270.

Stromeyer III, C. F. "Eidetikers," Psychology Today, November 1970, 76-80.

Stromeyer III, C. F. & J. Psotka. "The detailed texture of eidetic images," Nature, 1970, 225, 346-349.

Teasdale, H. "A quantitative study of eidetic imagery," Brit. J. Educ. Psychol., 1934, 4, 56-74.

Travers, R. M. W. Man's information system, Scranton, Penna.: Chandler, 1970.

Traxel, W. "Kritische Untersuchungen zur Eidetik," [Critical examination of eidetic imagery] Arch. ges. Psychol., 1962, 114(3-4), 260-336.

Underwood, B. J. Experimental psychology. (2nd ed.) New York: Appleton-Century-Crofts, 1966.

Vernon, M. D. Visual perception. London: Cambridge Univ. Press, 1937.

Walter, R. D. & C. L. Yeager. "Visual imagery and electroencephalographic changes," EEG clin. Neurophysiol., 1956, 8, 193-199.

Winer, B. J. Statistical principles in experimental design, New York: McGraw-Hill, 1962.

Woodworth, R. S. & H. Schlosberg. Experimental psychology. (Rev. ed.) New York: Henry Holt, 1958.

Ying, C. & C. H. Hang. A dictionary for young children, Taipei: Tong-Nien, 1970.