An Experimental Study of Related Processes in Span of Attention and in Perception

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AN EXPERIMENTAL STUDY OF RELATED PROCESSES
IN SPAN OF ATTENTION AND IN PERCEPTION

by

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CHAPTER I

INTRODUCTION

The present experimental study concerned itself with the possibility that a relationship could exist between span of attention, a type of organizational or grouping ability, and the ability to recognize a vaguely suggested object drawing. This experiment was suggested by some recent attempts to draw a distinction between organization of sensory materials on the perceptual level and perceptual organization of parts into a meaningful whole. The experiment consisted of the administration of two separate tests. The first test was given to determine the subject's span of perception for number of dots presented by means of a tachistoscope. The second, to determine the ability of the subject to recognize a familiar object or objects in figure ground relationships of graded difficulty.

If we had begun the study with an adequate definition of terms, it would have been impossible to know exactly where to draw the line between sensation and perception.

on the one hand, and between perception and higher processes on the other. The term sensation has been used by experimenters to refer to the sense organs with their nerves and nerve centers as the objects of study; perception, on the other hand, pointed to the objects of the world which are known through the senses. This laboratory distinction between an experiment on sensation and one on perception is reasonably clear. Woodworth points out that in a sensation experiment we apply stimuli that are restricted and typically simple, the attempt being to discover what impression or reaction resulted from these simple stimuli and their variation. He also states that in a perception experiment we present objects or objective facts in an attempt to discover how well they are observed. In both cases the subject has to be keenly attentive to what is presented and in both cases he gives a verbal report. It was our intention in this experiment to compare conscious reactions to simple dot stimuli with those which result from a presentation of vaguely suggested object drawings.

In studying the problem it was assumed that if two types of visual stimuli were presented to a subject it might be possible to demonstrate the individual's use of his sensory processes in the simple span of attention and in perception. The scores obtained with presentation of both types of visual stimuli would depend upon the individual's ability to attend to and organize the material in the test situation. It was considered to be conceivable that a correlative relationship might exist between span of attention for simple visual stimuli and the ability of the subject to perceive object relationships.

We believed that such an approach would indicate to what degree that which we have come to recognize as a form of objectively unified sensory perception might be influenced by subjective or attentional factors. This experiment was, therefore, primarily a study of sense experience and in addition an investigation of the unification of sensory materials into dynamic or organic wholes in perception.
Span of attention, as related to our problem, is closely allied to the field of perception. It is obvious that an individual's span of attention varies greatly with the total amount of attention given to a task by an observer. If the individual, while attempting to perceive the contents of a card tachistoscopically presented, allowed his attention to wander, the results of such an experiment would differ considerably from those obtained in a similar trial when full attention was given to the task. In brief, attention as evidenced by attention span was an important and partly controllable variable in our experiment.

The experimental procedure used in this study was strongly suggestive of some studies of learning stressed by Gestalt psychologists. The Gestalt psychologists interpreted learning as a matter of "Perceptual reorganization" or of "re-Gestalting." However, when they spoke of learning as a matter of perceptual reorganization, their examples indicated that they meant by this a change in associated or

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3 Robinson, M. D., "The Relationship Existing Between Span of Perception and Voluntary Shift of Attention" Loyola Thesis, 1944, 10
redintegrated meaning. When Köhler's chimpanzees learned to utilize boxes to reach suspended food, the change was one that could properly be called "perceptual reorganization," since perception was a broad term covering associated meanings as well as direct sensory experience. The change was not one that could have been called "sensory reorganization." The present study was concerned with processes whose content was primarily attention and perceptual reorganization.

Careful introspection on the part of many workers reveals that a fundamental distinction has to be drawn between attending as a conscious act and the body set which, often in a purely involuntary manner, accompanies the act. The literature reveals that some such distinction can be made when there is a question of experiments performed with animals. In animal studies it is pointed out that when the animal's cognitive faculties are directed toward the stimulus, this type of attention is confined to the act of attuning the receptors and effectors to a

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4 Leeper, R. L., "A Study of a Neglected Portion of the Field of Learning" Journal of Genetic Psychology, XLVI, 1935, 41

5 Köhler, W., The Mentality of Apes, Harcourt, Brace and Company, 1925, 58
state most favorable to a quick response. This set is not demonstrably conscious on the animal's part, since it is aroused only by an external stimulus or, perhaps, an image. It can in no sense be interpreted as voluntary. Reflex and instinctive behavior, modified within limits by sensori-motor learning or association, is sufficient to account for such an adjustment. Man, on the contrary, often displays a somewhat similar reaction, but in his case, the attentive attitude is subsequently modifiable at will, on the basis of certain consciously perceived goals to be attained. Our investigation aims at giving free play to all of the formal mental processes in order to discover actual relationships between them.

CHAPTER II

AN HISTORICAL RESUME OF THE BACKGROUND
AND RELATED LITERATURE

The Perceptual Reorganization Experiment:

Since the literature did not reveal a clear-cut approach to the problem as we have presented it, the salient features of the work reviewed are presented in the order of their appearance in the performance of the experiment. The suggestion for this experiment came from Gardner Murphy's discussion of a study by R. F. Street. The original study was intended as a study of a type of intelligence-test material. Street was interested in the question as to what correlation existed between the ability to complete such fragmentary visual figures and the ability to complete ordinary verbal completion tests. Murphy, however, referred to Street's materials to illustrate his suggestion that much of complex learning could be interpreted as a matter of perceptual reorganization. Leeper also used this material in his

1 Street, R. F., "A Gestalt Completion Test" Bureau of Publications, Columbia University, 1931

2 Murphy, G., A Briefer General Psychology, 1935, 257
study of the development of sensory organization in learning. In the present study Street's material was used as a means of investigating the sensory processes involved in perceptual reorganization.

In approaching the problem of perceptual reorganization it was deemed necessary to adopt a term that would signalize the result of the sensory process of perception. Claparede, who was concerned with a similar problem, used the term insight. The word seemed to him a good one for indicating the fact of perception of relations as distinguished from blind action. It seems to the writer, however, that the word, as used by Claparede contained a description rather than an explanation, and referred to a result rather than a process. Since we already have terms signifying the perception of relations the use of the term insight in this way was not a contribution to the list of psychological concepts.

The use of the term insight to refer to the result of a process soon indicated that it could also refer to the result of a variety of processes.

3 Leeper, R., "Study of a Neglected Portion of the Field of Learning" Journal of Genetic Psychology, XLVI, 1935, 41
4 Claparede, E., Archives of Psychology, XXII, 1934, 1
The process most relevant to the present study was the fact that instead of overtly manipulating or reacting to a problem situation, the human subject could employ imagination to that end, thereby saving useless movement, and often reducing time as well as actual errors. Discussions of this form of mental trial-and-error activity revealed that 'insight' and abstraction figured conspicuously in investigating the sensory processes of perceptual reorganization.

The literature pointed out that puzzle-solving showed much of this trial and error activity. Ruger conducted an experiment in which the material consisted of mechanical puzzles and the task was to disentangle the component parts of each of the puzzles. The observer kept a record of the moves made as well as the subjects' report of his experience. All subjects showed a considerable amount of overt trial-and-error behavior similar to that shown by cats in the problem-box. In addition, however, they showed in their reports of their experience a large amount of internal trial and error. The process of trial and error carried on in the realm of the inner responses, or thoughts,

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5 Ruger, H. A., Archives of Psychology, Vol XV, 1910, 6
seemed to be similar to the trial and error carried out in overt behavior. False steps were sometimes repeated and correct steps were often overlooked. Similar behavior was reported by subjects in our experiment.

A delay often occurred in an otherwise smooth curve as a result of an attempt to think out the problem. In those cases "thinking out" consisted of internal trial and error, without anything tangible to show by way of reward. It was possible in some such cases to reduce one's total time for the solution of the puzzle simply by stopping to engage in some mental trial and error at one point. However, the benefit one received from stopping and thinking sometimes occurred at a different point on the curve from that at which the thinking process had occurred.

These observations from work with puzzles were confirmed by subsequent investigation with geometrical forms in which complicated patterns were presented and the subject was required to find out what these patterns had in common and how they differed. He had to identify the logical thread which connected all the patterns.
In addition to the processes noted above, Ruger found many instances in which wholes were suddenly broken into their component parts by a process which he called analysis. We likewise found subjects who attempted to analyze the figures presented. Ruger, however, used the term to include all cases of sudden regrouping or repatterning which confronted the subject while working on a puzzle. The puzzles seemed to break up or alter while being examined. Such processes of analysis, together with a fresh integration of the parts, often attended the sudden improvement in the performance. The object ceased to be a confused blur; it was broken up and the relation of the parts to one another and to the whole was clearly seen. These observations tended to make an explanation of perception in terms of "reorganization" alone very unsatisfactory because the heart of the problem was the dynamic readjustment of a whole task rather than simply the independent shifting of the parts to make a new total.

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The human subject, as Ruger often pointed out, had gained insight into the situation, his intellect having grasped the principle involved in the problem even though the principles used required any number of distinct sensory perceptions. The subject experienced, therefore, no further difficulty in the solution of the problem. The actual extent to which intellectual functions were employed in any given situation was determined in part by the subject: his maturity, mental capacity, experience, special training and the like; and in part by the nature of the problem itself. Some situations obviously favor rational elements to a much greater degree than others; but it was probable that in all mature human perception or learning except simple conditioning, intellectual factors entered at some stage of the process contributing to the total synthesis of a variety of experiences. The "flash" of insight was more than superficially similar to a flash of lightning; it could have been based upon a sudden shift of equilibrium or a dynamic readjustment of the individual as a whole to the problem.
Emphatic descriptions of insight are found in Köhler's studies with apes, and also in similar studies made by Alpert with little children.

Alpert's general set-up was made as much like Köhler's situations as possible in order to study the relation of insight to trial and error. Forty-four pre-school children took part in two series of problems. The first series required climbing to reach a toy. In the second, an object was placed out of reach and had to be obtained somehow by the use of a stick. The usual variations were made in these problems.

The responses to the problem situations were grouped as follows: First, according to presence or absence of an attempt to solve the problem. The attempts were further grouped as direct or indirect. Some of the children went directly ahead, openly trying to solve the problem, while some walked about the room, glancing self-consciously at the toy and came to a solution only after much delay. The methods used in solving the problem were classified as: (1) Primitive responses - reaching with the

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Alpert, A. T. C. Contributions to Education, 1928 No. 323
hand toward the desired object, standing on tip-toe; (2) Random responses - all kinds of activity which had only a remote relation to what was wanted - this happened when the child was frustrated; (3) Exploration and trial-and-error elimination of false starts - the more difficult the situation, the more this response was called out; and (4) Immediate solution - the more often this was called out and the more clearly the idea of using tools was established, the less frequent became the random responses.

Insight was identified partly through the child's ability to use what he had learned as he passed to a new situation involving similar perceptions, partly also by a change in expression or a revealing remark, such as "Oh, I see," followed by rapid solution. The solution itself was the criterion of insight. The reorganization in the mind of the subject was not necessarily sudden. There seemed to be cases of gradual insight: first an awareness of need; then an awareness of the
means, betrayed by some such behavior as picking up the stick or looking at it, kicking it, and so on; finally, seeing the whole field in its relations. And there was "partial" insight, which evolved gradually, in contrast to sudden complete insight. Sudden insight, moreover, often emerged on the scene of action at the beginning of the following trial, as though it had matured between trials or was due partly to some change in attitude.

Insight, as manifest by perceptual repatterning, appeared to be found at an early stage in human development. There was little reason for saying it disappeared later. To find that it existed was one thing; to tell when it would appear was another. The author indicated that subjects were often resistive to insights; a false start often blinded them even to the trial-and-error possibilities which were before them. They not only failed to show insight; a wrong "set" prevented the appearance of the random movements which would have solved the problem.
Another experiment threw some light on the conditions of insight. Forty students were given a set of blocks and a base on which they were to build up the blocks to just reach two horizontal bars. The blocks could be put only one way to solve the problem. The subjects were told to handle the blocks as much as they liked but not to build until they had completed a plan. Forty other subjects were allowed to build immediately. They were permitted as many trials as they desired until they solved the problem or decided it was impossible. The trial-and-error subjects in every case repeated errors several times. This in itself suggested that the degree of insight involved here was slight, both imagery and behavior appeared to be directed chiefly through the medium of trial-and-error. The task was not one in which the necessary background of experience was available; there was, so to speak, almost no perceptual field to reorganize. Insight in this situation appeared

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to be dependent to a large degree on familiarity with the task. Perceptual reorganization, on the other hand, was subject to trial-and-error.

No less striking than the above was the tendency for the perceptual processes to shift their pattern of organization from time to time on the basis of physical and physiological factors. The shifting character of perception was, perhaps, best illustrated by means of ambiguous drawings. Material of this type was especially well suited for bringing out the dependence of shifts in perception upon the apparent characteristics of the stimulus objects. Evidently here we were dealing with looseness of organization and some amount of competition among the several determining factors in perception which were derived from the stimulus itself.

The fact that physiological as well as physical factors were involved in perceptual shifting could be inferred from the character
of the changes themselves and from the conditions which governed the individual differences. Subjects were found to vary considerably with regard to the rate at which any given figure appeared to shift; and this in itself was convincing, though not necessarily conclusive evidence of physiological influences.\(^9\) It was possible, moreover, to show that such conditions as fatigue, loss of sleep, and drugs affected the rate of change in ambiguous figures; all of which pointed to the significance of organic processes, as regulatory factors, at least. Finally, the comparatively small extent to which many such effects were directly controllable at will seemed to indicate their physiological basis.

Sister Robinson in her study of the relationship between span of perception and voluntary shift of attention found a high positive correlation.\(^10\)

This indicated that among her


\(^{10}\) Robinson, M. D., S.H.N. *The Relationship Existing Between Span of Perception and Voluntary Shift of Attention*, Loyola Thesis, 1944, 70.
subjects those who had broad spans of perception tended to have a high rate of voluntary shift of attention; those with narrow spans tended to have a low rate of shift of attention. These results were in agreement with those obtained by Father King, S. J., who found that, among his subjects, those who had a broad span tended to be low perseverates and those who had a narrow span tended to be high perseverates.

Sister Robinson's results agree with Father King's, for a high perseverate, whose tendency was to persist in an activity, would find it more difficult to voluntarily shift attention rapidly than would the low perseverate whose tendency it was to change quickly and easily from one activity to another. The subject with narrow span did not perceive as much in one glance and consequently he required more time to apprehend the various patterns. In order to shift the figure he first had to be able to synthesize all the parts into one pattern and then change to a new synthesis giving a new position. The

\[11\] "Komplexbreite und Perseveration", Archiv für die Gesamte Psychologie, XCII, 1934, S. 470
test on ambiguous figures required the voluntary shift of attention from one pattern to another and not merely from one isolated part of the figure to another. The subject with narrow span could not shift as rapidly because he could not synthesize as rapidly. He could not synthesize as rapidly as the subject with broad span because he could not synthesize the same amount into a whole or unit.

When we spoke of shifting from one activity to another or from one pattern to another in our experimental work, it must be remembered that we were speaking chiefly about the objective or externally manifest aspects of the activities and not about the inner processes of thought.

The Attention Span Experiment:

Schumann's studies of 1900-1904 in visual space developed the concept of attention as binding figure parts into the formation of a pattern and attributed the potency of this pattern to the
distribution of attention. As he used the term 'attention', it implied a dynamic tendency toward spontaneous subjective structuring of the field. This concept formed the basis for our assumption that in determining the number of dots on a card tachistoscopically presented the subject would have to group or organize the dots in some manner in order to determine the number on the card. A measure, the time of exposure, was decreased until the subject was required to rely upon the processes of perception to determine the number of dots on the card.

The recent experiments on span of attention and the related topic of perception of relations were treated from numerous and various aspects, and we refer at this point to only a few of the more pertinent ones. Chapman and Brown studied span in relation to the prominence of any individual content in the material presented. For example, they presented several series of letters and in

each series made one letter more conspicuous than the others by centering its position, enlarging its size, and changing its color. Their results were found to agree with Kulpe's principle which states: "The greater the range of attention, the lower is the degree of consciousness attaching to any individual content; while vice versa, the number of objects grasped by attention decreases as concentration upon any one of them increases." This principle was also demonstrated in Father Moore's doctoral dissertation. In his experiment a series of geometrical figures were exposed on a rotating disc for a quarter of a second. Five figures were presented on each exposure and in each group a figure common to all other groups was present, though its position changed upon every presentation. The subjects at the end of the experiment were asked to draw the figures they had seen. The

14 "The Problem of Attention," Monist, XIII, 1902, 57
results obtained clearly showed that the more prominent the common figure was in consciousness the more obliterated were the other figures.

Similarly span of perception was shown to depend on the amount of information demanded. A.D. Glanville and Karl M. Dallenbach performed an experiment in order to determine the average span for various types of material. They found that the span followed this order: greatest for number of dots, less broad for letters, geometrical forms, and, finally least for reports on both form and color. The fact that the span was least for reports on both form and color seemed to indicate that the span was lowered when there was little time for organization of the material. Where both form and color were reported the relative time allowed for active organization was much less than in those types of material where


only one element was required. The above increased our belief that the span for an individual on a specific type of material was greatly dependent upon the amount of organization which occurred in this type of perception.

In planning an experiment to test span of perception it was evident that the material used had to be carefully prepared so that the letters, digits, or words, would be in equal position, size, etc. For this very reason, dots presented on a card were much more uniform than either letters or numbers and tended to lend themselves to a more accurate test of visual span.

Glanville, Dallenbach, Fernberger, Oberly, Gill, and others all performed experiments on span of perception using plain white cards with black dots and exposing them by means of a tachistoscope. One of the most interesting experiments of the group was that of Sherman Oberly. He attempted to determine the span of perception for his subjects by three different methods
which he called span of attention, span of cognition, and span of apprehension. In the first, the subjects were limited to an immediate perception of dots which were equally clear; in the second, the same subjects were permitted to group and this was to indicate varying degrees of clearness, though no subsequent time was permitted for the calculation of dots apprehended; in the third test, the subjects were permitted to count, group, or attain their estimations by any means and were allowed time subsequent to the exposure before giving a judgment. The average spans obtained by these 17 methods were as follows:

1. Attention     -- 3.93 dots
2. Cognition     -- 6.91 dots
3. Apprehension  -- 8.21 dots

The author did not explain just how he stopped his subjects from grouping in the first trial,

thus the distinction between the methods used in attention and cognition was not clear. The method of apprehension, however, was the method ordinarily used to gauge span of perception.

These were but a sampling of the experiments and related literature, recent and otherwise, which concerned span of perception and the various aspects of perceptive reorganization. We see that in approaching the problem of perceptual reorganization it is necessary to adopt a term to signalize the result of the sensory processes of perception. Discussions of mental trial-and-error revealed that 'insight' and abstraction figured conspicuously in investigating these sensory processes. It was also apparent that there was a tendency for these processes to shift their pattern of organization from time to time on the basis of physical and physiological factors. We were justified in our assumption that in determining the number of dots on a card tachistoscopically presented the subject would have to group or organize the dots to determine the number present.
CHAPTER III
EXPERIMENTAL APPARATUS AND PROCEDURE

The general experimental procedure was as follows: First, to determine the individual's span of perception on the assumption that in determining the number of dots on a card tachistoscopically presented he would have to group or organize the dots in some manner in order to determine the number on the card, this approach would not give the subject sufficient time to count the number of dots present; second, to approach these same principles of organization from the standpoint of the individual's ability to organize and reorganize what appeared to be rather stable nonsense drawings until these figures could be recognized as pictures of familiar objects.

The two series of tests were administered individually to all of the subjects in two sittings not less than one hour apart. The subjects were all adults unacquainted with laboratory procedures. Scores were recorded for thirty subjects. Since the procedures were entirely different for each series of tests, they were considered under separate headings.
Experiment I

The first series of tests were those administered to determine the subject’s span of perception for dots. The requisites for a good tachistoscope are as follows:

A good set up provides a pre-exposure field of about the same brightness as the exposure field itself, so that the eyes are properly adapted in advance. A visible fixation point enables O to look in the right direction; and this fixation mark is practically at the same distance as the objects to be exposed, so that O’s eyes are properly focused and converged in advance. These are the elementary conditions of a good tachistoscope.

In arranging the apparatus for our experiment we endeavored to fulfill these elementary conditions. The room used for the tests was well lighted by indirect lighting. The machine itself was the vertical type having a shutter opened and closed by means of two coiled springs operating against gravity. The exposure time of one fifteenth second permitted a clear view of the card and yet was short enough to prevent the subject from getting two views.

Woodworth, 688
The apparatus was placed on a table of convenient height for the subjects. The subject was seated in a chair not more than three feet from the table. The subjects were permitted to determine the distance from the tachistoscope which was most comfortable for them. The shutter of the tachistoscope was composed of a light metal plate. A vertical line and a horizontal line were drawn in pencil lightly across the center of the shutter plate; the point of intersection was the point of fixation. The lines were drawn lightly enough so as not to interfere with the exposure and yet visible enough for the subjects to fixate with ease. Cards size 3 inches x 5 inches with 2, 3, 4, 5, 6, 7, to 14 ungrouped dots were presented in random order.

Before each experiment the distance between the subject and the point of fixation was measured and kept constant. The tachistoscope was briefly tested to assure the experimenter that the shutter was working properly and to acquaint the subjects with the procedure.

The experimenter attempted to put the subject at ease by telling him that the purpose of
the experiment was not to test his mental abilities but merely to see how many dots he could see during the short time of exposure. He was encouraged to attend closely and to do his very best.

The following instructions were given to each subject:

The cards which I am going to present will have dots on them. They will be shown in this small window for a fraction of a second. (Indicate) At the present time in this window you will see a metal plate upon which two lines intersect in the middle. The point where they intersect is the point at which you are to look when given the ready signal. Before each exposure I will say "ready," which is the signal for you to look. I will then expose the card in the window. After each exposure, I will ask you to tell me the number of dots you saw.

These instructions were given at least twice to each subject and more often if necessary. An attempt was made to avoid the use of such words as fixate, focus, fatigue. In the preliminary trials these words were found to confuse the subjects so that at the time of exposure they were concentrating upon 'fixating' so much that they forgot to make a serious attempt at determining the number of dots on the card.

After the preliminary trials the cards were
presented according to the foregoing directions and in random order according to the rules for the Constant Stimuli Method. Each card was presented at least ten times, unless the experimenter saw that it was too easy or too difficult altogether. Efforts were made to encourage the subjects to report what they saw and not to engage in random guessing or efforts to deceive the experimenter.

Instead of measuring the single responses, we classified them as right or wrong and determined the frequency in each class at each step of the stimulus scale. We then divided the absolute frequencies by the number of times the particular stimulus was presented to obtain the relative frequency of the different classes of response to that stimulus. Relative frequency

\[ \text{Relative frequency} = \frac{\text{Absolute frequency}}{\text{Number of presentations}} \]

To avoid recognition of any one pattern upon subsequent presentations the cards were inverted in alternate presentations. The answers were marked on a score sheet either correct or incorrect. From time to time the subject was asked if he was tired, and if so, was permitted a few minutes rest. For sample data sheet see Appendix IV page IV.
was expressed as a decimal fraction. We added the relative frequencies for each number of dots observed within the transition zone, the zone in which both right and wrong categories occurred. This transition zone was bounded by a basal value at and below which every trial was a success (or assumed to be such), and an apical value at and above which every trial was a failure. The method for computing the span from this data, the Sumation Method, was as follows:

We took the sum of the relative frequencies within the transition zone and multiplied it by the step interval, which in this case was one, and added this value to the basal score. To this sum was added 0.5, i.e., one half the step interval to give the "statistical" span. In this experiment we used the "Constant Stimuli Method" of presentation by presenting the cards in random order, and chose that point in the zone of transition at which approximately fifty percent of the judgments were correct, according to the method of Summation. 3

3 Woodworth, 400-403
Since our interest lay chiefly in getting the naive spontaneous responses of untrained subjects, the span of apprehension method was used in the experiment. The subject was permitted to count or group and ascertain the number of dots by whatever means he chose. All of our subjects were inexperienced in laboratory methods, and hence no directions were given as to methods of apprehension. They were merely asked to report the number of dots which they had seen. All of the subjects reported after the experiment that they had used both grouping and counting according to the relative difficulty of the card.
Experiment II

Construction of the Gestalt Completion Test:
The completed test was composed of items, each of which was a peculiar type of picture puzzle. By deletion, parts of each picture had been made to form the ground, so that in order to perceive the picture, it was necessary to complete the structure; that is, to bring about a "closure" which caused the figure to emerge from the ground. The items were constructed in black with a white ground.

In the construction of these items the problem of what was to be placed in the figure and what was to be allowed to merge with the ground was determined very largely by applying the important laws of perception suggested by Gestalt psychologists. Hsiao summarized these laws, which in part were as follows: Figure and Ground - Figure predominates; ground sets off. The figure had a definite structure; the ground formed the background. The figure was always more resistant to change than the ground. Law of Prägnanz - A Gestalt tended to become as sharply defined as possible. Closure-Mode of distribution of energy
shifts was in the direction of a minimum of Gestalt energy.

Figures 1, 2, and 3 (p. 36-38), show samples of the figures used as the main stimulus materials in this part of the study. Eight of these figures were taken from Street's collection, one was an adaptation of one of his figures, the other ten were figures constructed on the same principle as Street's by Leeper.

The experiment was conducted as an individual experiment and the figures were handed to the subject with proper orientation of top to bottom of the picture. The size of the pictures was 4 x 6½ inches in the case of the drawings which most completely filled the cards. (See Appendix I p. I)

The further details of the procedures used with the subjects was as follows: Before any of the figures were shown to a subject, instructions were given them covering the following points:

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You will be shown some figures which can be seen as well-unified and coherent pictures of certain familiar things, provided you "fill in", as it were, the spaces between the fragments shown. In case you see the correct picture, all of the different marks in drawing will be seen as belonging to the completed figure. In case you get a pattern which does not utilize all of the fragments, you can know thereby that you have not yet seen the figure intended.

To make these instructions clearer, the simplest figure of all was presented and the above instructions repeated with particular reference to this figure. Further instructions were then given regarding the recording by each subject on a sheet of paper what he had seen. Since the figures were of quite unequal difficulty the length of the exposure time was varied from 30 seconds for the easiest figures to not more than 3 minutes for the more difficult. After each figure had been shown, no explanation was given as to what had been represented. These further instructions covered this point.
Opposite the number indicating the picture which you have been given, you are to put down one or more words indicating what you have seen in the drawing and in parentheses, whether you have seen the object clearly and easily, or imperfectly and uncertainly. After you have secured one organization of the picture and have jotted down the items asked for above continue to observe the picture for the full exposure period. In case you see something different during the remaining period record what is seen and again whether it was seen vaguely or certainly. (For sample data sheet see Appendix II, p. II)

In scoring the papers, the procedure followed was naturally that of counting correct any answer indicating that the subject had seen the object represented, regardless of whether the specific words given in appendix III, page III were used. Four drawings (figure 3, p. 38) of nonsense material were scattered among the other drawings. These drawings received no score.

The request for an evaluation of the clearness of the object seen by each subject was due to the belief that a variable would be introduced by the arbitrary selection of 'correct descriptions' by the experimenter. (See sample data sheet Appendix II, p. II) It was believed that the subject's descrip-
tion of the figures could also be correct. The fact that the subject's description differed in detail from the description of the experimenter was no reason for assuming that the subject was totally wrong. The introspective reports made by many of the subjects indicated the distinction between the imaginal trial-and-error procedure in which the subject fitted his concept to that of the experimenter with the help of the material and the procedure in which the subject grasped the abstract principles and relationships which led to the subject's interpretation.

On the basis of these additional concepts the subjects were required to write on their data sheets the degree of clarity with which they had seen the figures. This clarity of perception score was also used as an evaluation of the subject's ability to visually perceive the drawings presented in this part of the procedure.

Woodworth pointed out that in a sensation experiment the experimenter was interested in the correlation of the report of the subject with a certain objective fact. The scores for the two

5Woodworth, 450
tests readily gave a numerical evaluation of the visual attention span of the subject and the ability of the subject to visually recognize through reorganization of part to part and to the whole the incomplete drawings. In the perceptual reorganization test, two standards of objectivity were used. In the first, the objective fact was determined by the experimenter; in the second, the objectivity was determined by the subject’s evaluation of the clearness of his percept. In analyzing the results the two standards of objectivity were considered separately.

The coefficient of correlation between scores on the Span of Attention Test for Dots and the Figure Completion Test using both standards of objectivity was found by the Product-Moment Method. This coefficient of correlation was considered sufficient, by the author, to determine the degree of relationship that existed between the two tests used.

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CHAPTER IV
RESULTS

In the experiments on span of perception and perceptual reorganization, both quantitative and qualitative results were obtained. The latter were volunteered reports, though a few questions concerning methods, experiences, etc., were asked of the subjects. The results were discussed separately for each test described in the procedure. The correlation between the two tests was investigated last.

Experiment I

As was mentioned in the previous chapter (p32), the method used for ascertaining the subject's span was the Constant Stimuli Method. Fernberger, in criticizing the work of Jevons, mentioned the greater accuracy of the Constant Stimuli Method as follows:

"The Statistical limen, that stimulus-value for which correct judgments are given in fifty percent of the cases, is the most reliable measure of the range of visual apprehension." ¹ A further explana-

¹ "A Preliminary Study of the Range of Visual Apprehension." The American Journal Of Psychology, 1921, XXXII, 133
tion of the meaning and accuracy of a limen so obtained was explained more fully in the same paper.

Limen is a statistical limen, a calculated quantity which summarizes observed results for purposes of scientific comparison. When one finds the upper threshold of tone to be say 18, 264 vs., one does not seek to construct a stimulus for this frequency in order to see whether it will give 50 percent positive judgments. One is satisfied with the computed limen as a part of a statistical account of observations already made.

The spans of perception for the thirty subjects in the experiment included a comparatively wide scatter with the individual limens ranging from 4.99 to 10.47 for dots. The mean for the entire group was 7.11 with a standard error of 1.31. The standard deviation was 1.36. (See Table 1 P. 45) This range and mean were in fair agreement with those obtained by other experimenters. Oberly, in his experiments on six subjects, obtained a mean of

\[ \text{Op. Cit., 123.} \]
<table>
<thead>
<tr>
<th>NAMES</th>
<th>SPAN TEST I</th>
<th>SCORE TEST II</th>
<th>RANK TEST I</th>
<th>RANK TEST II</th>
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<tr>
<td>PHe</td>
<td>10.47</td>
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<td>1</td>
<td>2.00</td>
</tr>
<tr>
<td>LFr</td>
<td>9.62</td>
<td>16</td>
<td>2</td>
<td>2.00</td>
</tr>
<tr>
<td>JKi</td>
<td>9.34</td>
<td>13</td>
<td>3</td>
<td>14.50</td>
</tr>
<tr>
<td>EDu</td>
<td>9.29</td>
<td>10</td>
<td>4</td>
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<td>9.10</td>
<td>14</td>
<td>5</td>
<td>9.50</td>
</tr>
<tr>
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<td>8.47</td>
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<tr>
<td>NHi</td>
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<td>24.50</td>
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<tr>
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<td>10</td>
<td>18.00</td>
</tr>
<tr>
<td>EHa</td>
<td>8.01</td>
<td>10</td>
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<tr>
<td>ESm</td>
<td>7.99</td>
<td>15</td>
<td>12</td>
<td>5.00</td>
</tr>
<tr>
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<td>13</td>
<td>13</td>
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<tr>
<td>JPo</td>
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<td>14</td>
<td>14.50</td>
</tr>
<tr>
<td>DBe</td>
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<td>15</td>
<td>15</td>
<td>5.00</td>
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<tr>
<td>JTh</td>
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<tr>
<td>VWo</td>
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<td>14</td>
<td>17</td>
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<tr>
<td>SGr</td>
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<tr>
<td>HMe</td>
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<td>7</td>
<td>19</td>
<td>29.50</td>
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<tr>
<td>RLa</td>
<td>7.26</td>
<td>12</td>
<td>20</td>
<td>18.00</td>
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<tr>
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<td>7.12</td>
<td>14</td>
<td>21</td>
<td>9.50</td>
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<td>22</td>
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<tr>
<td>MMa</td>
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<td>23</td>
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<td>FHo</td>
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<td>24.50</td>
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<tr>
<td>RRm</td>
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<td>25</td>
<td>29.50</td>
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<td>9</td>
<td>26</td>
<td>28.00</td>
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<td>CAn</td>
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<td>27</td>
<td>9.50</td>
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<td>10</td>
<td>28</td>
<td>24.50</td>
</tr>
<tr>
<td>GBr</td>
<td>5.71</td>
<td>11</td>
<td>29</td>
<td>20.50</td>
</tr>
<tr>
<td>HGe</td>
<td>4.99</td>
<td>10</td>
<td>30</td>
<td>24.50</td>
</tr>
</tbody>
</table>
8.21 dots for method of apprehension. Woodworth in a compilation of data obtained from experiments performed by Fernberger, Oberly, Glanville, and Dallenbach gave the mean for span of perception for number of dots as 8.36 and the variation of individual spans ranged from 6 to 11.

The limen for span of perception was not an invariable figure, and the threshold increased to a certain extent with practice. In a group of subjects such as ours, the spans obtained under similar conditions indicated the relative position of each subject in the group. The span, however, was not invariable for each individual. Tests under similar circumstances administered at different times to eight subjects showed this variability to be from 0.00 to 1.34. Oberly in administering the same test three different times, through restrictions of method which were different for each test, noticed the effects of practice. "All of the O's showed an increase in the size of the threshold as experimentation progressed." Woodworth also mentioned this effect of 5

4 Woodworth, 690–691
5 Oberly, 1924, 344
practice in his study of several experiments on span.

The scores on this test approximated the scores found in a normal distribution. In order to further check the reliability and accuracy of the first test a retest was given to eight of the subjects. Subjects were selected from the two extremes of the original thirty scores and from the middle group. The results for the retests are presented in Table III page 48.

Woodworth, 693
TABLE III
TEST RETEST SCORES FOR SPAN

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>TEST I SPAN</th>
<th>RETEST SPAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHe</td>
<td>10.47</td>
<td>11.81</td>
</tr>
<tr>
<td>LFr</td>
<td>9.62</td>
<td>9.62</td>
</tr>
<tr>
<td>JPo</td>
<td>7.72</td>
<td>7.53</td>
</tr>
<tr>
<td>DBe</td>
<td>7.71</td>
<td>7.81</td>
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<tr>
<td>JTh</td>
<td>7.54</td>
<td>7.54</td>
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<tr>
<td>VWo</td>
<td>7.48</td>
<td>8.01</td>
</tr>
<tr>
<td>GBr</td>
<td>5.71</td>
<td>5.72</td>
</tr>
<tr>
<td>HGe</td>
<td>4.99</td>
<td>5.21</td>
</tr>
</tbody>
</table>

These retests showed what was meant by increase in threshold of span and the constancy of span of perception. With two of the subjects LFr and JTh the span remained the same. In both instances different cards were missed but all at approximately the same level. The other subjects showed a slight increase in span with one exception JPo who showed a slight decrease. With GBr there was a slight increase which appeared when the calculation of span was carried to the third decimal place. JPo the subject who showed a decrease indicated several times that she thought this type of study was silly so it was apparent that she did not cooperate as well on the retest.

In explaining the method used in perceiving the number of dots on the cards all subjects reported
the use of both counting and grouping. This was evident in most cases during the tests. Some closed their eyes immediately following the exposure and counted the dots in the mental after-image. One attempted to calculate the number by grouping from top to bottom as the card was exposed. The cards having less than six dots were counted directly.

In general, the subjects tended to overestimate the larger numbers. Many reported directly that they could only guess when there were more than 10 dots. In no case were any of the subjects permitted to know the correct number of dots on the high cards. One subject asked specifically to see one of the cards so that he would have a frame of reference for judging the other cards presented.

Another point observed was the noticeable hesitancy to respond, on the part of the subjects where there was a question of numbers close to their limens. For example a subject whose span was 7.00 would generally take more time on cards 6, 7, and 8 than others either above or below.
In this connection there were several requests for retrials or a change in the answer given immediately following presentation. It was observed that these corrections were usually overestimated and incorrect.

Experiment II

The second test was given to determine the ability of the subject to reorganize what appeared to be rather stable nonsense drawings until simple figures or familiar objects were recognized. None of the subjects succeeded in clearly recognizing all of the figures. Since two standards were used in determining whether or not the subject had successfully recognized the figures the results are discussed separately.

When the answers were the same as those obtained by the experimenters (Appendix III, pIII) the highest score for our subjects was 16 out of a possible 19. The lowest score was 7. The mean for the entire group was 12.3 with a standard error of 2.09. The standard deviation was 2.34. The frequency distribution of these scores is presented in Table IV page 51.
TABLE IV

FREQUENCY DISTRIBUTION OF
FIGURE COMPLETION TEST SCORES

<table>
<thead>
<tr>
<th>INTERVAL</th>
<th>FREQUENCY</th>
</tr>
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<tr>
<td>8.00 - 8.90</td>
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<td>12.00 - 12.90</td>
<td>3</td>
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<td>3</td>
</tr>
<tr>
<td>16.00 - 16.90</td>
<td>3</td>
</tr>
</tbody>
</table>

After carefully considering the subjective nature of many of the responses to the figures, the subjects were asked to evaluate their answers from the standpoint of the clearness of the percept. If the subject's response differed from the correct answer as determined by the experimenter it was judged to be correct if the response was seen clearly. When the answers of the subjects were reconsidered on the basis of this clearness of the percept one score of 19 out of a possible 19 was obtained. The lowest two scores were 11. The mean for the group of scores was 14.50, the standard error 2.68 and the standard deviation 2.12. The frequency distribution of these scores is presented in Table V page 52. This standard deviation was 0.22 lower.
TABLE V

FREQUENCY DISTRIBUTION OF FIGURE COMPLETION TEST SCORES USING PERCEPTS CLEARLY RECOGNIZED AS CORRECT

<table>
<thead>
<tr>
<th>INTERVAL</th>
<th>FREQUENCY</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>13.00 - 13.90</td>
<td>6</td>
</tr>
<tr>
<td>14.00 - 14.90</td>
<td>5</td>
</tr>
<tr>
<td>15.00 - 15.90</td>
<td>4</td>
</tr>
<tr>
<td>16.00 - 16.90</td>
<td>4</td>
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<td>1</td>
</tr>
<tr>
<td>19.00 - 19.90</td>
<td>1</td>
</tr>
</tbody>
</table>

than the original in which the figures seen by the subjects were judged on the standard of correctness of the experimenters.

The coefficient of correlation between scores on the Span of Attention Test for Dots and on the Figure Completion Test was found by the Product-Moment Method to be $+0.382$ with a probable error of $\pm 0.07$. The completion test scores were derived by comparing the responses of the subjects to the correct responses as determined by the experimenters who devised the test. This coefficient of correlation, which was calculated from a correlation table, indicated that there was some relation between span, as we measured it, and the ability to see the incomplete figures. On the basis of such a correlation
one could not predict the standing of a subject in Test II from his standing in Test I or vice versa; yet, there was a tendency for the two scores to vary together.

The correlation coefficient between scores on Span of Attention and the scores on the Figure Completion Test, using all figures seen clearly as correct ones, was found, by the same method, to be $+0.369$, with a probable error of $+0.07$. This coefficient did not differ significantly from the first one in which the answers of the experimenters were compared with those of the subjects.

The results of these correlations, then, revealed that correlation was present but slight between Span of Attention for Dots and the ability of the subject to recognize a familiar object in figure ground relationships of graded difficulty.

In analyzing the qualitative results of this study it was noted that the instantaneous reaction of the subjects to the figures in Test II was somewhat significant. The subjects whose scores were high on this test were able to see the figures immediately upon presentation. Those whose scores were low found the figures difficult from the be-
ginning though with effort and practice they often were able to recognize one of the more difficult figures.

As a result of this observation we thought it advisable to separate the subjects into two groups and correlate them separately. When this was done, however, the correlations proved to be insignificant due to the small size of the sample.

At this point it might be pointed out that the usual process by which a subject was able to see the figures in Test II was a process whereby the figure changed from one organization to another in an all or nothing fashion. It was sometimes true that a subject would notice first one detail of the drawing, and then from that detail gradually assimilate one portion after another of the drawing until he was able to recognize the entire unit.

This process, however, was seldom demonstrated. The typical process for recognizing the figures was one in which the figure as a whole would change from one pattern to another.

In this case the subjects reported that at first the figure looked like so many jumbled marks that
would lead to one unification that would not appear to be satisfactory. As a result of this procedure several subjects saw the drawing of the rabbit, first as being, "fish jumping out of the water," or as "seals" or as "arms and hands". Since these patterns did not seem to be adequate, and the examination period was continued, the figure would next transform itself, perhaps, into something else until finally the correct figure was seen.

It was interesting that once an organization had been achieved, even where it was considered by a subject as being clearly incorrect it was difficult to exclude that organization and see something else. It appeared that with material of this kind, once an organization was achieved, that very fact seemed immediately to give a "sticking power" to that organization which tended to block any efforts toward reorganization. A "stamping in," as one might say, seemed to follow immediately and so naturally that it was easy to overlook the fact of its presence.

We were inclined to believe that the process
involved could best be described as follows:

The task of seeing the correct objects in these incomplete figures was a process of conflict and interaction in the nervous system between the spontaneous organizing factors and the redintegrative patterns, with their own tendencies of stress and closure, which were derived from the past experience of the person. These habit-derived organizations could win out over the spontaneous organizing influences by various means, as: a) perhaps the same casual process operated here which Köhler had suggested as a possible explanation of the phenomenon of reversible illusions - after one organization had dominated the central processes for awhile, its relative strength became lessened through some process of fatigue, which made it possible for some other organization to take the field even though it was less favored originally; or b) either because of some instructions that had been given or because the subject noticed some detail which suggested this or that total figure. The subject then re-integrated some sensory organizations

7 Köhler, W., *Gestalt Psychology*. New York: Liveright, 1929, 403
from his past experience which redintegrated patterns then tended, though not necessarily immediately, to cause an assimilation of the observed fragments into a new total organization.

Köhler also pointed out that this latter operation could be envisaged as a process of perceptual overlap, or perceptual superposition, very probably analogous to the process found in a binocular-rivalry situation. It appeared as though in redintegration there was aroused in the brain a pattern of nervous activity which was similar in distribution and in properties of dynamic organization (except intensity or steadiness) to the pattern of central nervous activity set up directly by sensory stimulation.

8 Op. Cit., 403
CHAPTER V
SUMMARY AND CONCLUSIONS

The original statement of the problem questioned the possibility that a relationship could exist between span of attention, a type of organizational or grouping ability, and the ability to recognize a vaguely suggested familiar object drawing. This investigation was a study of two levels of sensory experience, and a study of the sensory processes involved in the unification of material into dynamic or organic wholes. If span of perception, as we measured it, is indicative of a type of organizational or grouping ability, there ought to appear a relationship between this ability and the ability of the subject to recognize a vaguely suggested object drawing.

The statistical procedures used indicated that some relationship existed between the two processes investigated. The coefficient of correlation between scores on the Span of Perception Test for Dots and on the Figure Completion Test was found by the Product Moment Method to be $+0.382$ with a probable error of $+0.07$. This is a just barely significant correlation.
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PERIODICALS


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UNPUBLISHED MATERIALS

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APPENDIX I

FIGURE CARD AS USED IN TEST II - ACTUAL SIZE
APPENDIX II

SAMPLE FIGURE COMPLETION TEST DATA SHEET

1. Head of Man (clear)
2. Dog (clear)
3. Cat (clear)
4. Sailboat (clear)
5. Looks like an animal sitting there (very vague)
6. Stove (clear)
7. A little dog (very vague)
8. Rabbit (clear)
9. Bird (vague), fat old owl (vague)
10. Dog sliding to a stop (vague)
11. Dog with its head tilted (clear), Clown (vague)
12. Clock (vague)
13. Bus (clear)
14. Side of house (vague), Shoe (clear)
15. Lopsided head (vague)
16. Airplane (clear)
17. Elephant (vague)
18. Ladies high heeled shoe (vague), Elephant head (clear)
19. Typewriter (clear)
20. Saw (clear)
21. Work shop (very vague)
22. Car (clear)
23. Violin (somewhat indistinct), Banjo (clear)

Comments: The general impression seemed to have been there all of the time. When I tried to make them out I conjured up things to put there. Sometimes I tried to bring the pieces together a little. If I couldn't get all of the pieces in I just guessed. It wasn't really a guess because I always got the hint when I first looked at the picture.

Subject: DBe
Score 15, Rank 5
Score based on Clearness: 17, Rank 4.
APPENDIX III

CORRECT ANSWERS FOR THE FIGURE COMPLETION TEST

1. (Man's Head)
2. An animal (dog) (puppy)
3. An animal (cat) (dog)
4. A means of transportation (boat) (Sail boat)
5. Nonsense picture
6. A piece of household equipment (stove)
7. An animal and a person (Man on Horseback)
8. A small land animal (Rabbit)
9. A means of transportation (Locomotive) (Engine)
10. Nonsense picture
11. A child and a Toy (Boy and tricycle)
12. A piece of household equipment (Alarm Clock)
13. A means of transportation (Bus) (Truck)
14. (Shoe)
15. Nonsense picture
16. A means of transportation (Airplane)
17. An animal (Elephant)
18. An animal and a person (Boy and Dog)
19. (Typewriter)
20. Nonsense picture
21. A common tool (Saw)
22. A means of transportation (Automobile) (Car)
23. A musical instrument (Violin)
APPROVAL SHEET

The thesis submitted by Jesse Ralph Pearson has been read and approved by three members of the Department of Psychology.

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the thesis is now given final approval with reference to content, form, and mechanical accuracy.

The thesis is therefore accepted in partial fulfillment of the requirements for the Degree of Master of Arts.

June 19, 1949
Date

Signature of Adviser