A TEST OF IMMEDIATE MEMORY

A Thesis

Presented to

The Committee on Graduate Studies and Research

University of Manitoba

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

---

by

James George Dark

April 1950

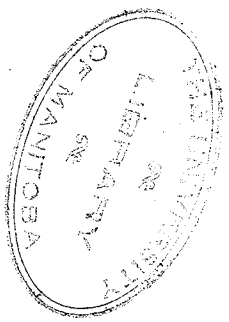


TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
II.	A SURVEY OF MEMORY	6
III.	DESIGN OF TEST INSTRUMENT	16
IV.	TESTING THE HYPOTHESIS	22
V.	EXPERIMENTAL PROCEDURE	28
VI.	EVALUATION OF THE TEST	39
VII.	SUMMARY, PROBLEMS AND CONCLUSIONS	57
BIBLIOGRAPHY		67
APPENDIX A,	TABLES	69
APPENDIX B,	FIGURES	88

LIST OF TABLES

TABLE		PAGE
I.	Serial Order of Presentation of Lines to Form Various Plates	70
II.	Preliminary Test-Run Raw Data September, 1949	71
III.	Means and Standard Deviations Preliminary Test-Run Material (First Presentations, Only)	72
IV.	Differences of Means Preliminary Trial	73
V.	Means for First and Subsequent Presentations of all Plates Preliminary Trial	74
VI.	Serial Order of Presentation of Plates to Groups Experimental Trials	75
VII.	Experimental Trials Raw Data	76
VIII.	Means and Standard Deviations for first Presentations at Experimental Trials	79
IX.	Individual Totals for Experimental Trials	80
X.	Correlations between Types of Material in Experimental Trials	34
XI.	Differences of Means in Experimental Trials	36
XII.	Reliability Co-Efficients from First and Second Presentations in Experimental Trials	81
XIII.	Condensed Data for Plates Selected for Final Test Form	82
XIV.	Raw Data from Test-retest	83

TABLE

XV. Raw Data from Immediate Memory Tests..... 84

XVI. Test-retest Means and Standard Deviations..... 85

XVII. Differences of Means Final Trial..... 86

XVIII. Correlations of Various Memory Tests..... 87

LIST OF FIGURES

FIGURE		PAGE
I.	Standard Grid Used for Presentation of Lines.....	89
II.	Meaningful Plates.....	90
III.	Gestalt Plates.....	91
IV.	Nonsense Plates.....	92
V.	Master Chart of Lines Used for Plates.....	93
VI.	Individual Sheet for Reproduction of Lines.....	94
VII.	Distribution of Means for First Presentations at Experimental Trials.....	95
VIII.	Digits for Oral Presentation.....	96
IX.	Digits for Visual Presentation.....	97

CHAPTER I

INTRODUCTION

Much has been written and said, and many tentative theories have been advanced with respect to the phenomenon of creative thought. Undoubtedly, too, much more will be written and many further theories will be propounded before there is complete understanding of this process. The rather common experience of having the solution to a bothersome problem suddenly come into one's consciousness at a time when there is no conscious effort to find a solution poses some interesting problems. Obviously, the elements required for the solution of the problem were present at an earlier period, but there was, at that time, an inadequate organization of those elements. The process which results in the synthesis of these elements in the intervening period is probably the central aspect of the entire problem. With a view to making one further attempt to determine the psychological factors involved in this phenomenon, the present investigation has been undertaken.

Initial consideration of the problem led to the following assumptions: (1) Memory for the discrete elements of the problem must be assumed; (2) There might be supposed to be a process of synthesis occurring, previous to the solution of the problem; (3) A process of organization must be assumed to account for the re-organization of the elements

into an organized totality; (4) In certain instances, at least, the entire phenomenon would seem to occur at a level below that of consciousness. It may well be that there are other significant implications that may be drawn from a consideration of this problem, but these are the specific assumptions that have been selected as worthy of investigation for the purposes of this research.

Historically, there is little evidence that the process of synthesis has received much consideration in studies of this nature. In general, the approach has been made upon the assumption that the analysis of existing wholes has resulted in the organization of certain of their elements into a new structure. It is a commonly accepted psychological truism that material with meaning to the subject is better remembered than meaningless material. If there were a test composed of discrete elements from figures of varying degrees of meaningful organization, and if the elements from the meaningful patterns were better remembered than those from the nonsense patterns, we might well deduce that the elements, in the first case, had been subject to a process of organization. Subjective reports from the test subjects might be expected to indicate whether this process had occurred at a level below that of consciousness.

With these considerations, and the previous assumptions, in mind, there would seem to be evidence of a line of appro-

ach to the general problem. It was felt that a study carried out along such a line of approach might, conceivably, result in the addition of a useful contribution to the general body of psychological knowledge. Such a study would imply attention to the following factors; memory, particularly of an immediate nature; and a process of synthesis of discrete elements which might take place at a level below that of consciousness. Careful consideration of the entire problem led to the establishment of a tentative hypothesis upon which to carry out the investigation. The hypothesis was stated as follows:

> 'Creative thought may be partially accounted for in terms of a process of synthesis, sometimes occurring at a level below consciousness.'

A survey of existing material for research in this area did not reveal a suitable instrument for the investigation. This pointed to the necessity for the designing of an aid that would serve the purposes required for the specific study which was being undertaken. Briefly, the requirements were that the material should be such that it should be composed of apparently meaningless elements which might be presented in temporal sequence to a group of subjects. The elements must be such that they were subject to a process of immediate memory. There must be a process of reproduction, at the end of the serial presentation, which

would yield evidence of a process of synthesis occurring below the level of consciousness. With these requirements in mind, steps were taken to devise a suitable test and this problem seemed of sufficient magnitude that it became the problem of this thesis. The larger, or more general, problem was deferred for a further study at a later date, when the necessary instrument should have been designed and tested.

As a result of this decision, emphasis was shifted from the problem of creative thought to that of immediate memory, as this was felt to be a suitable area in which to devise the required instrument. Whitmer states:[1] "Other things being equal, a memory is most accurate when recall is made immediately following the observation" Individual differences in rate of forgetting would be kept at a minimum by such use of the material. Also, there would be more possibility of detecting the organizational factor at the below consciousness level in a test of immediate memory than in a test of the more traditional type. To meet the necessity for group presentation, it was decided to make a visual presentation of the material and to have the reproduction take place in the motor field. With these considerations in mind, the following hypothesis was framed:

---

1 J. Stanley Gray, et al., Psychology in Use (New York: American Book Company, 1941) P. 458

'It is possible to design a test of immediate memory in which apparently meaningless elements may be presented visually in temporal sequence, and reproduced by a motor process. It will involve synthesis of these elements in such a manner that there will be significant evidence of a process of organization at a level below consciousness.'

CHAPTER II

A SURVEY OF MEMORY

Traditionally, any survey of memory starts with a consideration of Ebbinghaus and his famous experimental work in this field. However, there seems to have been little interest in the particular aspect of the general field of memory with which this research is concerned, that of immediate memory. In that, and many of the later studies of a similar nature, the emphasis has been placed upon the retention, reproduction, recognition, recall, and loss of material that had been memorized over a period of time and with many repetitions of the material. Essentially, such a procedure becomes an investigation of learning and has little reference to the problem of immediate memory.

Brennan[1] has defined the psychological aspects of memory in terms sufficiently generalized that they may be applied to all the various forms of memory. He states that the process of memory has the following implications: (1) An original impression; (2) A certain amount of effort at fixation; (3) Unconscious retention of what was perceived; (4) Formation of mental images for future reference;

---

1 Robert Edward Brennan, General Psychology (New York: Macmillan Co, 1937), P. 241.

(5) Restoration to the field of awareness; (6) The presence of an element of time awareness. It might be pointed out that, although it is no concern of this immediate discussion, this definition limits the field of discussion by the elimination of the sort of memory which occurs when there is no evident effort at fixation. This is sometimes referred to as incidental memory. However, the limitation of the field of memory by definition is by no means uncommon. Barrett[2] defines memory as a process that is invoked when a perception has sunk into unconsciousness and has then been recalled. Also, Spearman[3] states that immediate memory is measured, or is operative, when there has been no interval of forgetting. A nice theoretical point is raised here. To what extent can a perception sink into unconsciousness without forgetting taking place? What are the limits of the interval after perception which will allow it to sink into unconsciousness, and before the process of forgetting sets in? It may be that Barrett has excluded immediate memory from his definition. If this were the case, most of the present tests of immediate memory-span would be ruled out of consideration.

---

2 James Francis Barrett, Elements of Psychology (Milwaukee: Bruce Publishing Company, 1931), pp. 67f.

3 Carl Spearman, Psychology down the Ages Vol. II (London: Macmillan and Company, Ltd., St. Martin's Street, 1937), p. 63.

It would seem possible that these difficulties of definition are an outgrowth of the basic uncertainty as to the exact nature of memory. Although it is one of the most commonplace of all phenomena, there is actually very little exact knowledge concerning it. Many theories, and many classifications, have been advanced, but none have met with anything approaching universal acceptance. Murphy[4] states that there have been two dominant theories of memory current since the seventeenth century. The first theory has postulated that memory is the ultimate power of the mind and soul. This has been the theory that has been followed by the faculty psychologists. The second theory is that memory is simply a name for the process by which experiences are reinstated through re-excitement of their physical bases in the brain. This has been a more widely accepted theory as it has been applied in association psychology, in behaviourism, in the Gestalt trace theory, and in the field theory canalizations.

Bridges[5] points out an inherent weakness in the behaviourist theory of memory. He believes that such a theory

---

4 Gardner Murphy, Historical Introduction to Modern Psychology (New York: Harcourt, Brace and Company, 1932), p. 200.

5 James Winfred Bridges, Psychology, Normal and Abnormal (New York: D. Appleton and Company, 1932), p. 251.

implies the persistence and reproduction of behaviour patterns in an unconnected series of flashes of experience. This is based upon the concept of the one-to-one relationship between stimulus and response and the re-excitation of the response only by the original stimulus. Obviously, such a concept leaves no place for the process of organization with respect to the products of memory. The results of the present research would seem to indicate that there is a process at work below the level of consciousness, between the time of perception and the time of reproduction.

Bridges[6] further suggests that we should not refer to a single memory, but, rather, to a number of memories for a number of specific things such as words, faces, names, digits, etc. This is a concept which meets with wide approval among present day psychologists. Ellis[7] states, "Even so, it should be clear that there is no single memory capacity but that there is a possible memory for each kind of elementary conscious experience."

Although there is general agreement as to the diverse sorts of memory, there is anything but agreement as to the exact classifications which are to be established. However, there is fairly general unison in making a distinction be-

---

6 Ibid.

7 Robert Sidney Ellis, The Psychology of Individual Differences (New York: D. Appleton and Company, 1928), p. 61.

tween immediate and other types of memory. A general division into immediate and permanent memory is suggested by Collins and Drever[8]. They suggest that immediate memory may be measured in terms of memory span. Repetition of the material used for this measurement will result in learning and will establish permanent memory. Carlson and Carr[9], and other experimenters, have differentiated between rote and logical memory, but some difficulty seems to arise in the matter of an exact definition of logical memory. Boring, Langfeld and Weld[10] cite the well established fact that exceptional ability to memorize is usually restricted to a narrow class of material. This would seem to be a further indication of the existence of a number of types of memory.

Thurstone[11] reports that memory appears as a group factor in many experimental studies. He suggests differentiations between: (1) Incidental memory and memorizing; (2) Rote memory and memory for ideas. He also points out

---

8 Mary Collins and James Drever, Experimental Psychology (London: Methven and Company, 36 Essex St. W.C., 1926), p. 255.

9 H. B. Carlson and H. A. Carr, "Rote and Logical Recognition Memory", J. Exper. Psychol., 26; 1940; 109-210.

10 E. G. Boring, H. Langfeld and H. Weld, Foundations of Psychology (New York: John Wiley and Sons, Inc. 1954, 1948), p.169.

11 L. L. Thurstone, "Primary Mental Abilities", Psychometric Monographs, No. 1, (Chicago: University of Chicago Press, 1938), p. 86.

that there is usually a low correlation between different forms of tests of memory. He suggests two possible explanations for these results; (1) There may be a separate memory factor for each memory modality; or, (2) There may be a general memory factor, and a separate imagery factor for each modality. He considers that there is ample ground for further experimentation in this specific field.

In 1885, Sully[12] formulated a rule with respect to memory which postulates that; "...the higher the sense in point of discriminative refinement, the better the corresponding memory." He then lists the corresponding memories in descending order as; sights, sounds, touches, tastes, and smells. To a certain degree, this theory is still valid in that it is commonly agreed that memory for visual perceptions is better than for auditory sensations.

Delay[13], more recently, has suggested an interesting hierarchy of three memories. They are listed as; (1) Sensori-motor, (2) Social, and (3) Autistic. He points

---

12 James Sully, Outlines of Psychology (London: Longmans, Green and Company, 1885, second edition), pp. 282f.

13 Jean Delay, "Les trois Mnemres", J. psychol. norm. path., 1940; 41; 57-8, 374-393. (Cited in Psychological Abstracts; 21, 1947.)

out that in the process of individual evolution from infancy to adulthood these memories are developed in the following order; sensori-motor, autistic, and, finally, social.

One further example of the problems arising in the field of memory is to be found in Rapaport's[14] discussion of Wechsler's Digit-span Sub-test. This quotation reflects the attitude of the clinical psychologist to the problem.

> "Digit Span has usually been assumed to be a test of memory in general, and "memory-span" in particular. In the theoretical understanding and clinical experience of the present authors this assumption is incorrect. Theoretically, the function of memory refers to logically meaningful and emotionally relevant material which has been assimilated in reference to interests, attitudes, affects, and striving of the individual. . . . The difficulty of Memory Theory is reflected in the fact that the literature--as well as clinical practice--repeatedly makes a distinction ... between immediate (recent) and delayed (remote) memory. It is highly questionable whether the immediate and delayed memory phenomena of the laboratory, and the recent and remote memory phenomena of clinical and life observation, are altogether comparable life entities."

Various other examples of the conflicting opinions with respect to classification and definition of memory could be cited. However, the above references should amply indicate the need for more exact knowledge of all aspects of the memory phenomenon.

---

14 David Rapaport, Diagnostic Psychological Testing, Vol. 1, Menninger Clinic Monograph Series, No. 3 (Chicago: The Year Book Publishers, Inc., 304 South Dearborn Street, 1945), pp. 176f.

Petermann[15] and Freeman[16] have drawn upon Gestalt theory to point to the importance of organization in its effects upon the products of memory. Petermann suggests that there is a modification of the elements remembered with a view to their better organization and toward the good gestalt. In the checking of the record sheets during the present experimentation, there has been evidence of this tendency. In many of the figures, which had a degree of organization, record sheets presented evidence of shifting of the positions of elements with a view to a better gestalt. No statistical evidence can be supplied, at this point, but the experimentor is satisfied that the tendency exists.

Freeman states that the tendency toward closure and the good gestalt operates even against the interests of memory. It seems reasonable to assume that it might also act in the interest of memory, and result in a larger memory product from material which was subject to organization than from material not so designed. With this in mind, the test instrument has been designed with a view to the use of the tendency toward the good gestalt.

---

15 Bruno Petermann, The Gestalt Theory, and the Problem of Configuration (London: Kegan Paul, French, Trubner and Company, Ltd., Broadway House, Carter Lane, E.C., 1932), pp. 246 ff.

16 Ellis Freeman, Principles of General Psychology (New York: Henry Holt and Company, 1939), p. 455.

Bartlett's[17] definition of memory has considerable significance, in terms of the underlying postulates assumed for this investigation. He states:

> 'Remembering is not the re-excitation of innumerable fixed, lifeless and fragmentary traces. It is an imaginative reconstruction, or construction, built out of relation of our attitude toward a whole active mass of organized past reactions or experience."

A definition by Moore[18] provides an even better clue to the actual processes to be tested by the new test, or by any other test of immediate memory, for that matter. He defines memory as:

> ". . . a function of the organism by means of which past experience is stored and later recalled when needed. When it occurs as a conscious state of awareness with conscious reference to past experience, it is a mental product."

This definition postulates two specific functions of memory; (1) The storing of experience, and (2) The recall of what has been stored. These are the two functions which any test of memory, immediate or otherwise, must set out to test.

Although much of the material presented in this survey chapter does not seem to have very close connec-

---

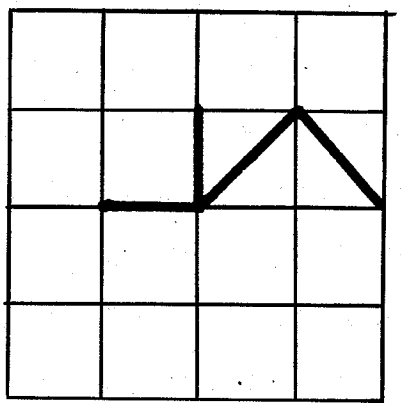
17 F. C. Bartlett, Remembering: a Study in Experimental and Social Psychology (New York: Macmillan Co., 1932) (Cited in Psychological Abstract 7; 1933: Abstract No. 3691)

18 Dom Thomas Vernor Moore, Cognitive Psychology (New York: J. B. Lippincott Company, 1939), p. 409.

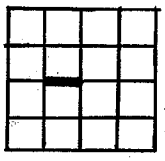
tion with the specific problem of designing a test of immediate memory, there have been experimental results with some bearing upon most of the problems suggested. Insofar as possible, in a paper of this length, attention will be drawn to these as they occur.

CHAPTER III

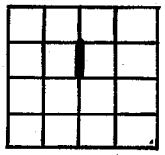
DESIGN OF TEST INSTRUMENT



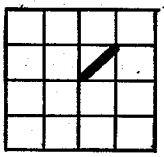
A



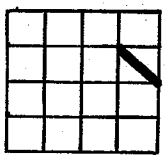
B



C



D



E

Woodworth[1] has made certain statements with respect to immediate memory which are of considerable value in the construction of an instrument of measurement for this function. [2]He states that the testing of immediate recall is one form of testing memory. [3]He suggests that it is usually convenient to use equal units of material for such a test.

---

1 Robert S. Woodworth, Experimental Psychology (New York: Henry Holt and Company, 1938).

2 Op. cit. p. 6

3 Op. cit. p. 7

[4]relations and patterns make learning easier. [5]Visual presentation is usually better than auditory. With these considerations in mind, along with the previously mentioned[6] requirements of the test instrument, the actual design of the test was undertaken.

Discrete elements were provided in the form of short lines. From these lines, plates were designed, as demonstrated at the beginning of this chapter. Assuming that the desired completed figure is to be of the form shown in A, four cards, B, C, D, and E, would be required for presentation to the subjects. These four cards demonstrate all types of lines used. None of the vertical or horizontal lines were placed upon the outer frame of the grid of sixteen squares.[7] Each individual line was drawn in India ink upon a separate card. In many cases, it was possible to save effort by rotating the cards through 180 degrees, thus causing them to serve double duty.

The next step involved the preparation of nine plates, or figures, which could be composed from these individual lines. So that the required measure of the organizational

---

4 Op. cit. p. 53.

5 Op. cit. p. 42.

6 Cf. Chap. I, p. 3.

7 Cf. Appendix B, Figure I.

factor in the reproduction of the material might be obtained, three separate types of figures were designed. The first three figures were such that a meaningful pattern would emerge upon correct reproduction of the nine distinct lines required to construct each of them. For convenience of tabulation, these were designated M1, M2, and M3.[8] Next, three plates of a balanced, or Gestalt, design were devised. These were designated G1, G2, and G3.[9] Every effort was made to design these figures so that there would be balance and pattern, without meaning. Finally, three plates were designed which had neither balance nor meaning. These were termed Nonsense plates and were labelled N1, N2, and N3.[10]

Since the individual lines were to be presented serially, it became necessary to determine the most suitable order of presentation for each plate. For each plate, three different orders of presentation were devised. These were designated A, B, and C, in presumed order of ascending difficulty.[11] (The numbers used to represent the various

---

8 Cf. Appendix B, Figure II.

9 Cf. Appendix B, Figure III.

10 Cf. Appendix B, Figure IV.

11 Cf. Appendix A, Table I.

lines may be checked by reference to the master chart[12] of all possible lines upon the grid.) Order A, insofar as possible presents the lines in spatial sequence and, usually, each line is connected with the previous one presented. Order C separates the successive lines as widely as possible and does not, in general, have successive lines contiguous. Order B is a combination of the other two orders. Plate M1 now had to be considered under the separate code forms of M1A, M1B, and M1C. In effect, this provided twenty-seven different plates to be tested for their efficacy.

As a mechanical means of presentation of the material to the experimental groups, a Spencer Delineascope was procured. The individual cards were prepared upon white poster card such that they would slide easily through a convenient slot just below the slide through which the regular card containers are placed in the machine. This placed the poster cards farther from the mirrors than is usual for projection, but the results were quite satisfactory.

So that the correct series of cards might be conveniently located during the actual period of presentation, a slotted holder was designed so that the nine required cards might be inserted individually, sloping slightly away from the operator. This, complete with cards, was placed at the

---

12 Cf. Appendix B, Figure V.

right side of the machine. Each card was removed, in order, from the holder and was placed in the slot with the right hand. After an exposure of one second, it was removed with the left hand to make way for the next card in the series. Projection was carried out upon a convenient wall or projection screen.

So that there might be uniformity of reproduction, mimeographed sheets,[13] showing the grid in exact form, were prepared in large numbers. In actual presentation of the material, the name of the subject was placed upon the first sheet only and the bundle of sheets from each subject was placed in a separate envelope at the end of the test period. The number placed upon the sheet identified the particular plate that had been presented for reproduction and the presentation number of the plate; e.g. M1B1 indicated the first presentation of Plate M1B; M1B2, the second presentation of Plate M1B; etc.

For ease of scoring, nine glass plates were prepared, each having one of the required figured stencilled upon it in India ink. These plates were identified M1, C2, etc., in ink on adhesive tape attached to the upper right-hand corner of the glass. When the glass plate was placed over the answer sheet, the number of lines on the sheet which

---

13 Cf. Appendix B, Figure VI.

corresponded to the correct figure were easily counted and tabulated.

With this material prepared, it was possible to redefine the hypothesis to state:

'A suitable selection of the above-described test material will, when administered serially, in the modality of vision, and reproduced with pencil upon paper, measure individual differences in immediate memory. It will, at the same time, yield statistically significant group differences in the number of lines remembered from the different types of figures. Further, there will be a descending average number of lines remembered, in the order; Meaningful, Gestalt, and Nonsense.'

CHAPTER IV

TESTING THE HYPOTHESIS

With the experimental material prepared, it was felt that it would be advisable to make a small-scale check upon the material before proceeding with the full-scale investigation. This was expected to serve two important purposes; (1) A preliminary test of the hypothesis would be obtained, and, upon the basis of this, revisions of material, alteration of the line of approach, or any one of a number of courses of action might be indicated. (2) Faults in the mechanics of presentation and procedure might be detected and corrected. In point of fact, the group serving as subjects adopted a very co-operative attitude, and their constructive criticisms were of considerable value, at this stage of the project.

The nine members of the Third Year (Honours) Experimental Psychology class were asked to serve as subjects during one of their regular laboratory periods. While it is fully realized that is is a highly selected group and one that cannot, by any stretch of the imagination, be considered psychologically naive, the limitations imposed by these conditions were off-set by their ability in the above-mentioned constructive criticism.

For the purposes of presentation, an arbitrary selection of order B of each plate was made. Each plate, as represented by nine individual cards, (a series), was to be presented three times, in immediate sequence. Reproduction was to be attempted at the end of each series. This made a total of twenty-seven presentations, in all.

It should be pointed out, at this point, that it was fully realized that learning would occur during the presentation of the plates. It was assumed that this would be of two separate forms. (1) There would be learning of the individual plates from first to second to third presentation. (2) There would be a general process of learning, involving, among other things, familiarity with the test procedure, realization that certain of the plates resulted in definitely organized forms, development of techniques of orientation of the lines upon the grid, etc. The first of these was subject to investigation in terms of differences in scores at successive presentations. This was expected to reveal information with respect to the suitability of the test as a test of ability in learning. The second type of learning was expected to prove a more disturbing element in the statistical treatment of the resulting data. Consequently, in order to take account of the series effect, the following balanced order of presentation was adopted; M1B, u2B, N3B, c5B, a1B, s2B, h3B, k4B, c1B.

M22, M32, G13.

The material was presented exactly as planned, with a metronome indicating the time interval for presentation of each card. The manual of administration, which was changed very little during the course of the research, will be found in Chapter VI of this thesis.[1] When time was allowed for reproduction of the lines and for the sorting of the cards, nearly an hour was required for the administration of the material.

At the conclusion of the presentation of the test material, criticisms were invited and received. Many minor faults of presentation were indicated, and these were corrected before subsequent use of the material. The chief criticism concerned the disturbing effect of the metronome. As a result, the metronome was abandoned, and the technique of counting, "Thousand-and-one", etc., (learned while doing aerial photography), was substituted. This proved very satisfactory and, although there was probably some slight loss in accuracy of timing, there is no reason to assume that the significance of the results is in any way impaired. In addition, personal observation of the methods of procedure indicated several points that were worthy of correction before proceeding further. These were largely concerned with the mechanical aspects of sort-

---

1 See Chapter VI, p. 41.

ing the material, arrangement of the supply of cards, technique of passing them through the machine, and other related matters.

When the raw data[2] was analyzed, the results were distinctly encouraging. Means and standard deviations were calculated for each plate and for each type of material (Meaningful, Gestalt and Nonsense).[3] An inspection of these figures discloses a satisfactory trend in support of the hypothesis. There are definite, and reasonably consistent, increments of memory from Nonsense to Gestalt to Meaningful material. In certain of the plates, MLB for example (the first plate presented), the results do not appear satisfactory. However, to at least some extent, this is explainable in terms of lack of familiarity with test material, procedure, etc. It should be noted that these statistics are calculated upon raw data for first presentations, only, of each plate. In this way, the specific learning of individual plates is removed from the picture.

With respect to types of material, further statistics were derived. Means, unbiased estimates of standard devia-

---

2 Cf. Appendix A, Table II.

3 Cf. Appendix A, Table III.

tions for types of material, and correlations between experimental results of different types of material are listed in the appendix.[4] Differences between the means for the different types of material were computed as Student's "t" ratios. Correlations between materials was taken into account in these calculations. The results, along with suitable estimates of their chance probability, are listed in Table IV. Differences between Meaningful and Gestalt, and between Gestalt and Nonsense failed to reach statistical significance. However, there was a good deal of consistency in the results; a very small number of subjects were employed in the preliminary test; and only a portion of the available material had been used. In view of these facts, it was decided that the results were sufficiently encouraging to warrant continued investigation along the same line.

As a matter of interest, when the means of the first and subsequent presentations of the same plate are considered, there is strong evidence of the specific learning process for individual plates. Means of results of first, second and third presentations are listed for each plate, in the appendix.[5] This tends to confirm the possibility

---

4 Cf. Appendix A, Table IV.

5 Cf. Appendix A, Table V.

that some form of this test material might be adapted to study of problems in learning. Also, consideration of Table III reveals strong evidence that the postulated general learning process takes place. In general, there is a trend to higher means within each type of material as subsequent plates are presented.

Analysis of the results of the preliminary tests of the material resulted in the following conclusions: (1) The results, although not always statistically significant, revealed a strong trend in support of the hypothesis; (2) The sample group employed had been small, highly selected and far from naive; (3) Only a part of the available material had been used. In the light of these conclusions, there seemed to be adequate grounds for testing of the hypothesis upon a larger scale. This, then, became the next, and the most arduous, step in the experimentation.

CHAPTER V

EXPERIMENTAL PROCEDURE

The first step in the experimental procedure was that of arranging the minimum number of trials that would be required to allow for a proper presentation of the entire range of material. As an initial step, three sub-tests were established. Each of these consisted of one order of difficulty of each of the original nine plates. Each of these three sub-tests was arranged in three serial orders calculated to balance out all series effects. In the final arrangement[1], each of the nine plates appeared once in each serial position in the order of presentation, and each received an equal amount of practice effect. Nine separate groups of subjects were required. Arbitrarily, four subjects were considered sufficient for each group. This meant that thirty-six subjects were required.

To obtain the necessary subjects, volunteers were requested from the Fourth Year General Psychology Seminar groups. They were assigned to groups of four, at random. It must again be admitted that these subjects were not psychologically naive. However, since the majority of them had little or no knowledge of experimental procedure, to

---

1 See Appendix A, Table VI.

this extent, they were more suitable subjects than the first group had been.

These group trials were carried out over a period of about a month, at times suitable to the experimenter and to the subjects. Conditions of presentation were maintained as constant as possible for all groups. Presentation was made upon the same screen, at the same speed, and with identical instructions. The overall time of presentation decreased from approximately forty-five minutes to forty minutes at subsequent presentations. This decrease was the result of better techniques of sorting of material between presentations and might be expected to have little, or no, effect upon the data obtained. The usual time of testing was just after the noon period. The seriousness with which the subjects carried out the task and the interest that was shown leaves one with little doubt as to the accuracy of the results that were obtained.

Since the purposes of the research called for consideration of the differences between different orders of presentation of the individual plates, and of the differences between types of material, tabulation of the raw data was carried out in such a manner that these results would be most readily available.[2] Also, since the research was

---

2 See Appendix A, Table VII.

essentially concerned with the data from the first presentations of each plate, further treatment will be made in terms of these figures, only, unless specifically stated otherwise. In passing, it should be noted that these data fully confirm the evidence of learning, as between first, second, and third presentation of each individual plate. This, again, points to the possibility of making use of some modification of the present procedure in the matter of measuring learning.

From this point, in the investigation, a two-fold direction of attack was adopted. The immediate problem of selection of suitable material from the larger body at hand implied one direction of interest. From further statistical treatment of this data, it was hoped that one specific order of difficulty for each plate might be adopted in the construction of a suitable test instrument.

The second line of approach involved a consideration of the original hypothesis. Insofar as possible, the material was to be checked with respect to its adequacy as an instrument for the detection of organizational factors in the process of immediate memory. Whether or not this process of organization occurred consciously was checked by means of subjective verbal reports of the subjects at the conclusion of the test period.

A further table[5] of individual totals for each type of material, and for all types of material, was drawn up. With a view to determining the type of distribution to be obtained with such material, tests of normality were applied to individual total scores for first presentations of all types of material. For this type of material, the use of "k" statistics seemed to be most suitable, and the following results were obtained:

G_1	-0.1119	S.E.	0.3025	"t" -0.29
G_2	-0.5447	S.E.	0.7681	"t" -0.71

("t" .05= 1.96; "t" .01= 2.58)

Neither of these results is significantly different from the normal curve of distribution. On the basis of these results, there would seem to be good possibilities of making a suitable selection of this material to devise a test which will give a normal distribution of scores in a population. Whether such a distribution will occur in other than a selected population, such as has been used for this investigation, is a matter for future checking upon a more general group.

Table VI was then analyzed by routine analysis of variance technique. The following results were obtained:

---

5 See Appendix A, Table IX.

SOURCE OF VARIATION	S.S.	D.F.	M.S.	F	$F_{.05}$	$F_{.01}$
Between Individuals	717.9	35	20.54	1.46	1.59	1.93
Between Materials	482.7	2	241.35	17.17	3.13	4.98
Error (Interaction)	982.6	70	14.04			
TOTALS	2183.2	107				

These results are encouraging, in both respects. The variance of scores due to types of material presented is significant far beyond the 1% level. If the material is to serve the purpose for which it is designed. This is a primary requirement. Obviously, this requirement has been satisfied.

With respect to the differences between individual scores, the situation is not as satisfactory as might have been desired. However, the results are actually very little short of the 5% level. From previous analysis, it is known that there is a distribution not significantly different from normal. Also, the population used for the test of the material is a highly selected group in which we may expect to find a somewhat smaller than usual spread of scores. In addition, at this stage of experimentation, the raw body of material has not been selected or refined. With these facts in mind, it may be assumed that the results are acceptable.

With a view to further analysis of the raw data, means and standard deviations were calculated for the three orders of difficulty of each of the nine plates; for all

plates of a given type of material, and for all plates, combined.[4] From this data, two purposes were to be served; (1) Some indication might be obtained as to the suitability, for inclusion in the final form of the test, of the different orders of difficulty of the various plates. (2) Signific/ance of differences between types of material might be calculated in terms of the differences between means. Since both problems entail the use of certain correlation data this will be discussed below.

When correlations between the results from the different types of material were attempted, it was not expected that they would prove to be very high. There were at least two factors which might operate against a high correlation. If organizational differences in the material introduce differences into rote memory, correlations should be reduced. Secondly, the balanced order adopted in the arrangement of the plates resulted in differences in the practice effect upon any given plate, when it was presented to different groups. Consideration of Table VI suggested that groups of twelve subjects, for whom this practice effect had been held to a minimum, might be selected. Groups 1, 6, and 8 had worked with Meaningful material first, Gestalt second, and Nonsense Third. Consequently, these

---

4 See Appendix A, Table VIII.

twelve subjects were treated as a single group. Similarly, Groups 2, 4, and 9 were treated as a single group, as were Groups 3, 5, and 7.

The correlations[5] from these groups pose somewhat of a new problem. There is a consistently higher correlation between Meaningful and Nonsense plates than is to be found

TABLE X

CORRELATIONS BETWEEN TYPES OF MATERIAL EXPERIMENTAL TRIALS

	Groups 1, 6, 8	Groups 2, 4, 9	Groups 3, 5, 7	Mean
Meaningful-Gestalt	0.21	0.26	-0.22	0.09
Gestalt-Nonsense	0.00	0.28	-0.41	-0.01
Meaningful-Nonsense	0.62	0.61	0.50	0.57

in the other correlations. This correlation tends to approach statistical significance. Correlations involving Gestalt plates, although usually positive, and low, tend to be much less consistent. This, combined with evidence presented in the next paragraph, may indicate a weakness in the Gestalt material. However, this does not seem sufficiently evident to warrant removal of Gestalt material from the new test form.

5 See Table X, p. 34.

As a further check upon this factor, a graph[6] was prepared showing the distribution of means of each type of material. This indicates that the Gestalt material is less clearly grouped than is the case in either of the other types of figures. The curve for the Gestalt means falls between the curves of the other means. However, the over all mean for Gestalt material falls relatively mid-way between the means for Meaningful and Nonsense plates.

Differences between means of scores for types of material were treated exactly as in Chapter IV.[7] Unbiased standard deviations were computed and the significance of of the differences between means was calculated, with due consideration for the related nature of the three types of material. For convenience, a summary of these results is tabulated below.[8] The use of correlation coefficients is somewhat unsatisfactory as there are three separate figures for the correlation between each two types of material. In each case, the mean of the three figures has been employed. The fact that there is another opportunity to check this same factor with better statistical methods makes possible the use of a somewhat doubtful method at this

---

6 See Appendix B, Figure VII.

7 Cf. Chap. IV, pp. 25 f.

8 See Table XI, p. 36.

stage. Since there are thirty-six subjects, in this case, "t" ratios have been checked for significance in Table XI against the normal curve. (Use of 34 degrees of freedom,

TABLE XI

DIFFERENCES OF MEANS
EXPERIMENTAL TRIALS

	Mean	S.D.
Meaningful	17.75	3.52
Gestalt	15.47	3.96
Nonsense	12.58	1.98

	"r"	Diff. of means	"t"	Significance 5%	Significance 1%
Meaningful-Gestalt	0.09	2.28	2.67	1.96	2.58
Gestalt-Nonsense	-0.01	2.89	3.84	1.96	2.58
Meaningful-Nonsense	0.57	5.17	17.05	1.96	2.58

in Student's "t" tables would result in the first difference falling very slightly below the 1% level of significance.) As the material has been treated, there is statistical significance in all differences between group means for types of material. Either the use of a larger body of material, or the use of a larger group of subjects, or a combination of both, has resulted in the attainment of

statistical significance where results slightly below the level of significance were obtained in the earlier test-run. This was more satisfactory evidence that some real difference was operative in the reproduction of the lines forming the three different types of figures.

As an aid to the selection of the most suitable plates for the final form of the test, an attempt was made to gain some indication of the reliability of each of the three orders of difficulty of each of the nine plates. Data were readily available with respect to first and second trials of each of the twenty-seven orders of presentation. In each case, there were twelve subjects, which provided a sufficient body of data for a rough check. To some degree, this approximated the test-retest situation. Correlations were carried out upon these individual first and second presentation scores, and these are listed[9] in Appendix A.

It then became possible to decide upon the nine plates (one order of difficulty of each of the original nine plates) that would be used as a test of immediate memory. Selection was based upon a number of criteria. Plates with a high reliability were desired. The mean was required to approximate the mean of all the plates of the specific type. The means of the three selected plates of

---

9 See Appendix A, Table XII.

the given type should be relatively the same. Means of all selected Meaningful plates should fall above the means of all selected Gestalt plates, which should, in turn, exceed the means of the Nonsense plates. Variance should not be too high or too low. Of the two, low variability would probably be the least desirable as this usually indicated too easy an order of presentation which did not discriminate satisfactorily between individuals. Too high a variability would indicate an undesirable occurrence of extreme scores.

Selection was made with a view to satisfying as many of these criteria as possible. The following plates were chosen; MLA, MZA, MXB, GLC, GZB, GSA, NLB, NZC, and NSB. Each of these plates could not, of course, meet all the requirements, but it was felt that the selection of each was indicated in terms of the total requirements. A condensed table of relevant data, with respect to these plates, is given in the Appendix.[10]

---

10 See Appendix A, Table XIII.

CHAPTER VI

EVALUATION OF TEST

When the final selection of the material for the test had been made, it became necessary to evaluate the test in the form in which it now existed. It was not felt that data for the performance of each of the selected plates in previous trials would provide an adequate measure of the performance to be expected in the new situation. The primary problem was that of establishing the reliability of the test, but there were a number of other matters that could be investigated at the same time.

One of the secondary problems was that of checking the performance of the new line test against that of other tests of immediate memory. Other reports indicate almost complete unanimity as to the low correlations between immediate memory tests in different modalities, and with different types of test material. With this in mind, it was decided to try this test against other memory tests in the same and different modalities and with some variation in material used. There was a further question of determining the type of distribution that might be expected from scores for each type of material (Meaningful, etc.), and from total test scores. Finally, there was the necessity to try correlations between the scores for the three types of

material to determine whether the low correlation between Gestalt and other types of material was still present in the final choice of material.

Once again, to account for the series effect, a balanced order of presentation of the plates was adopted. Since two orders of difficulty for each plate have been discarded, future reference to the plates will be made without use of the letters A, B, and C. The following order of presentation was used; M1, G1, N1, G2, N2, M2, N3, M3, G3.

Presentation was carried out exactly as in the previous trials, except that the entire equipment was moved into one of the lecture theatres to ensure adequate seating accomodation for the subjects. Projection, which was very satisfactory, was carried out upon a standard projection screen. The interval between presentation of plates was slightly longer because of the necessity for sorting a new series of cards after each serial presentation. Later,[1] in the evaluation of this test, this difficulty will be discussed and recommendations will be made for its elimination.

Minor alterations were made in the manual of presentation of the material, to arrive at the final form given below:

---

1 Cf. Chap. VII, p. 64

"I am going to show you nine series of lines through the dellneascope. The lines will be placed upon the grid horizontally, like this; vertically, like this; or diagonally, like this, or this." (Demonstrate four types of lines in indicated order, at indicated times.) "The grid will always consist of sixteen dotted squares, the same as you have on the sheets of paper in front of you. There will be no vertical or horizontal lines upon the outer lines of the grid. At the end of each series of nine lines, you will draw as many of them as you can remember, in their proper positions upon the grid on one sheet of the paper. When you have completed the drawing of the lines, you will be given a number to place upon the sheet. Then turn the sheet face down, in front of you, and watch for the next series of lines. Use a fresh sheet of paper for each series of lines. Place your name upon the first sheet, only. Are there any questions?"

"All ready for the first series? Watch closely, and remember the lines!"

Present first series (M1), allowing one second for each card. At the end of the series, say, "That's all."

When reproductions are completed by the group, say, "That was sheet number 1, number it and turn it face down in front of you. Ready for the next series: watch, and remember the lines." (Present S1).

Repeat procedure until test is completed. Have each subject fasten the nine sheets of paper together with a paper clip. Collect the sheets for scoring.

The next step was that of selection of suitable tests of immediate memory against which the new line test might be checked. Normally, this would be termed validation of the test. However, previous reports, and the results of this experimentation, suggest that there is no way of validating a test of immediate memory by the use of other tests. There is no evidence that others who have designed such tests have adopted this technique.

The first such test selected was the memory sub-test from the Chicago Test of Primary Abilities.[2] This is a test of immediate memory for names, presented serially, and visually, and reproduced by means of recognition in a multiple choice situation. The modality of presentation is similar, and the form of reproduction has some elements in common with the methods employed for the line test. It might be noted that the response involves recognition rather than reproduction. The material is different, in that names, with their meaningful and associative values, are used. It is also probable that the exposure time of fifteen seconds per name allows for more memorization and learning than might be expected to occur in the line test.

As a second test of immediate memory, half of the digits[3] from the Wechsler Digit sub-test were presented orally. The method of administration had to be adjusted to the group situation. The digits were read at the standard rate of one per second. Reproduction was made by writing each series, in turn, upon a sheet of paper. Numbers were presented for both forward and backward reproduction, as in the usual Wechsler sub-test. As a criterion of scoring, it was decided that the last number of

---

2 See Chicago Test of Primary Mental Abilities (Chicago: Science Research Associates. 228 S. Wabash Ave., Chicago 4).

3 See Appendix B, Figure VIII.

digits correctly reproduced, before two successive failures, should be the subject's digit-span. This provides another test of immediate memory in a different modality, that of voice, and with a different type of material, which should entail less of meaningful and associative values, than in the case of the names.

It was further decided to present a digit series in the modality of vision. To make this as nearly approximate to the line test, as possible, it was decided to present the digits through the delineascope. Each number series was printed, with Speedball equipment, on a strip of manila tag. A slide was devised from poster-card such that these strips might be passed easily through, from side to side. An aperture was cut in the poster-card, of such size that one number would show at a time. The numbers selected were the other half[4] of the Wechsler Digit sub-test material. Presentation was carried out at the rate of one digit per second. Reproduction, and scoring criteria, were the same as in oral presentation of the digits.

With a view to testing the reliability of the test, in its present form, it was decided to make two separate and complete presentations of the test. This would provide the test-retest situation much more adequately than had been

---

4 Cf. Appendix D, Figure IX.

possible from the previous data.

With all the material prepared, the order of presentation of the various tests of immediate memory was arranged as follows:

1. Line test.
2. Digits, ~~vocally~~ ORALLY, forward.
3. Digits, ~~vocally~~ ORALLY, backward.
4. Memory sub-test from Chicago Test of Primary Mental Abilities.
5. Digits, visually, forward.
6. Digits, visually, backward.
7. Line test, re-test.

Subjects for this series of tests were drawn from volunteers from the Third Year Industrial Psychology class. This is a class composed of at least three different faculty groups and is, in general, psychologically much more naive than either of the previously tested groups. Once again, the highly interested and co-operative attitude of the group allows one to place a high degree of reliance in the results obtained from their work. Twenty-two subjects did the first line test. One had to leave at that time, so there were twenty-one who did this and memory tests 2 to 6. At this point, six others had to leave to attend classes, leaving fifteen who took part in all presentations of material. Statistical treatment is based, in every case,

upon the largest possible number of cases, in view of the above incomplete data.

The test session was carried out in the order planned, and without incident, except that at least two subjects recorded oral digits backward, from right to left. Short breaks were allowed between tests, during which the experimenter told the subjects something about research work. This provided a certain measure of relaxation from the test situation. It was hoped that this would decrease fatigue effect, and would maintain a high degree of interest in the proceedings. The entire series was given in a period of a little less than two hours. It is not thought that fatigue effect has been any considerable factor to be taken into consideration in analysis of the results.

Raw data from this experimental series are listed in two tables. The first[5] lists raw data and necessary totals for the two presentations of the line test. The second[6] contains raw data for the other five tests of immediate memory. All digit scores are in terms of digit-span, as determined by the highest correct number of digits reproduced before two successive failures. Scores for the "M" factor of the Primary Mental Abilities Test are the number of names correctly recognized in the multiple choice groups.

---

5 See Appendix A, Table XIV.

6 See Appendix A, Table XV.

The data from the twenty-two subjects were first tested for the distributions of scores that would result from the use of the test. Each type of material was tested, as well as the total scores for all types of material. Again, "k" statistics were employed, and the following results were obtained:

			S.E.	"t"
Meaningful	S 1	-0.5055	0.4910	-1.03
	S 2	-0.3803	0.9528	-0.40
Gestalt	S 1	0.1982	0.4910	0.40
	S 2	0.4116	0.9528	0.43
Nonsense	S 1	-0.0136	0.4910	-0.03
	S 2	-0.0564	0.9528	-0.06
Full Test	S 1	-0.2250	0.4910	-0.46
	S 2	-0.2732	0.9528	-0.29

Since this is a normal distribution, in all cases 1.96 marks the 5% level of probability and 2.58 marks the 1% level of significance for the "t" ratio. In no case is there a significant deviation from the normal curve of distribution of scores. The fact that each of the different types of material, as well as the full test results, provides this distribution is distinctly encouraging.

Routine analysis of variance was carried out as in Chapter V.[7] The scores were analyzed with respect to variance between materials and variance between individuals

---

7 Cf. Chap. V, p. 32.

to yield the following results:

Source of Variation	S.S.	D.F.	M.S.	F	F.05	F.01
Among Individuals	661.70	21	31.51	18.01	1.81	2.33
Among Materials	272.85	2	136.42	77.95	3.22	5.15
Error (Interaction)	73.48	42	1.75			
TOTALS	1008.03	65				

Since both of these results are significant far beyond the 1% level, there is good reason to believe that this test will indicate individual differences in immediate memory and that it will yield significant differences in scores between different types of material used in the test. Thus, two of the prime requirements of the test are satisfied.

Means and standard deviations were then calculated for all plates, for types of material, and for the total test.[8] Statistics for the first trial of the test are based upon all twenty-two subjects. As pointed out in a previous discussion of earlier data,[9] certain plates (N1 and N3) indicate means somewhat at variance with the general trend of their type of material. This would seem to be explainable in terms of the position of the plate in the presentation of the test. N1, with an unduly low score, was the first plate presented; N3, with an unusually high score, was the last Nonsense plate presented. It is noticeable that in the data for the second presentation of the

8 See Appendix A, Table XV.

9 Cf. Chap. IV, p. 25.

test, to the same group, the overlaps between types of material have been almost eliminated. In general, however, Meaningful plates place above Gestalt plates, which exceed Nonsense plates, when the effects of learning have been counterbalanced.

With a view once again to testing the significance of the differences of means between the different types of material, unbiased standard deviations and correlation coefficients were derived. The summarized data are presented in the Appendix.[10] Since there are only twenty-two subjects to consider Student "t" tables have been used, with 20 degrees of freedom. In this case, the difference between Gestalt and Nonsense falls just above the 5% level of significance. There are probably a number of reasons for this. A slightly smaller group of subjects had been used; the final selection of material from the larger group seems to have caused the general mean of the Gestalt plates to fall somewhat closer to that of the Nonsense plates and relatively farther from the mean of the Meaningful plates. However, there is a real difference with respect to average number of lines reproduced. Also, this difference has appeared in three different presentations of varying selections of the material to different groups of subjects. It would seem that the importance of definite

---

10 See Appendix A, Table XVII.

statistical significance becomes somewhat less under these conditions than when only one sample group are under consideration. It is quite probable that increase in the size of the sample group would result in this difference becoming statistically significant. It is also highly probable, but yet to be determined, that the use of less highly selected groups would result in wider spreads in scores.

Further consideration of Table XVI indicates empirical evidence of the general learning factor at work during the total presentation of the test. There is a general upward trend of means within a given type of material, in accordance with the serial order of presentation. Empirical evidence of the specific learning of each plate is also evident in a comparison of first and second presentations of the test. Statistical evidence of this form of learning will be offered below.

Palmer Johnson, in his recent publication[11], reports an analysis of variance technique which was applied to the test-retest data with interesting results. Letting X represent totals for second presentation of the test and Y represent individual totals for first presentation of the test, he presents the following formulae:

---

11 Palmer O. Johnson, Statistical Methods in Research (New York: Prentice-Hall, Inc., 1949), pp. 139 ff.

$$\text{Practice Effect S. S.} = \frac{1}{2}\left[\frac{(\Sigma (X-Y))^2}{N}\right]$$

$$\text{Between Individuals S.S.} = \frac{1}{2}\left[\Sigma(X+Y)^2 - \frac{(\Sigma (X+Y))^2}{N}\right]$$

$$\text{Error S.S.} = \frac{1}{2}\left[\Sigma (X-Y)^2 - \frac{(\Sigma(X-Y))^2}{N}\right]$$

$$\text{Total S.S.} = \Sigma X^2 + \Sigma Y^2 - \frac{(\Sigma(X+Y))^2}{2N}$$

$$(\text{Sensitivity})^2 = \frac{\text{Between Individuals M.S.} - \text{Error M.S.}}{2(\text{error M.S.})}$$

$$(\text{Sensitivity})^2 = \frac{\rho}{1-\rho}, \text{ where } \rho \text{ is the estimated reliability for the population.}$$

Application of these formulae to the total results for the first fifteen subjects results in the following analysis of variance table:

Source of Variation	S.S.	D.F.	M.S.	F	F.05	F.01
Practice Effect	634.8	1	634.8	34.96	4.60	8.86
Among Individuals	3374.8	14	241.06	13.28	2.64	3.70
Error	254.2	14	18.16			
Totals	4265.8	29				

Sensitivity = 2.48, with 0.98 probability that it lies between 1.14 and 4.91.

Estimated population reliability = 0.86

These results provide strong support to previous findings. As indicated in the results for variance due to practice effect, there is evidence of learning of the test from trial to trial beyond the 1% level of probability. The adequacy of the test to measure individual differences, which

has previously been shown,[12] is again sustained beyond the 1% level. These findings are, in fact, merely confirmation of what has been known, or suspected, before. However, there is new evidence introduced with respect to sensitivity and reliability.

Sensitivity is defined[13] as; the ratio of measurement of individual differences to errors in measurement. Since this ratio is normally distributed, the present result indicates significance at better than the 5% level. The estimated reliability coefficient for the test is interesting in view of the fact that routine correlation procedure reveals a reliability of 0.87. This will be discussed more fully below.

Various correlation procedures were applied to these data with a view to checking reliability of the test, and to the gathering of further evidence with respect to some previous problems. The first correlations derived were those between scores for the first and second trials of the full test. They were tabulated for each type of material and for the test as a whole, as follows:

Meaningful	0.73
Gestalt	0.69
Nonsense	0.72
Full Test	0.87

---

12 Cf. Chap. VI, p. 47.

13 Johnson, op. cit. ref. 11, Chap. VI.

These results indicate a consistent reliability in each of the types of material. In addition, the over-all reliability of 0.87 would appear to be a satisfactory figure. Reliability coefficients for tests of immediate memory seem difficult to locate. However, Garrett and Schneck[14] report the following figures; 0.83 and 0.73 for two studies of digit span in the modality of hearing, and 0.74 for visual digit span. In the light of these reported figures, the reliability of the present test would seem to be adequate.

Further correlations were carried out between the scores for the different types of material. The following correlations were obtained:

Meaningful-Gestalt	0.51
Gestalt-Nonsense	0.43
Meaningful-Nonsense	0.65

This is a similar picture to that found in similar treatment of earlier data.[15] However, in this case, all correlations are somewhat higher. On the basis of this, and the previous results, there seem to be definite indications of some difference between the Gestalt and other types of material. In addition, there is, for some reason, a closer relationship indicated between the Meaningful and Nonsense material than between either of these with the Gestalt material. These results would seem to suggest a problem

---

14 Henry E. Garrett, and M. R. Schneck, Psychological Tests, Methods and Results (New York: Harper and Brothers, Publishers, 1933), pp. 132 f.

15 See Chap. V, pp. 34 f.

that would be a suitable subject for further research. The present treatment has not revealed the reason for what appears to be a consistent trend.

Correlations were then computed to determine the relationships between scores on the different tests of immediate memory. There were twenty-one subjects who had taken part in all of these and all data are calculated upon the twenty-one cases. These results are entirely similar to the results reported by other experimenters in this area, in that they are very low and not obviously consistent with anything. These results are reported in the Appendix.[16] Some of the figures prove interesting, in the light of previous reports. Garrett and Schneck[17] cite Garrett and Gates for a correlation of 0.57 between auditory and visual digit span. The present experimentation indicates a correlation of 0.56 between auditory and visual digit span for digits forward, but auditory and visual digit span for digits backward reveals a correlation of 0.02. Rapaport[18] cites a letter from David Shakow reporting an "r" of 0.57 between digits forward and digits backward. The present results indicate 0.72 in the same correlation for digits presented visually, but 0.09 in the case

---

16 See Appendix A, Table XVIII.
17 Garrett and Schneck, op. cit., p.52..
18 Rapaport, op. cit., p. 12.

of the traditional auditory presentation. It should be pointed out that there is some slight doubt as to the accuracy of the results from the oral presentation of digits for backward reproduction.[19] Not too much reliance can be placed upon the results obtained. Valentine[20] reports a range of correlations, for memory tests using six types of material, from 0.06 to 0.91 with an average of 0.38. The present range extends from -0.09 to 0.72, with an average of 0.29. It is probable that the introduction of differences in modality has contributed to the generally lower results, in the present case. While there are many other references to the fact that low correlations do exist, these are the only cases in which the definite "r" figures were cited.

No thing very definite results from an attempted analysis of the results of the present group of correlations. The line test shows a higher correlation with the results of the Chicago sub-test than with any other. Considerations of the modality of presentation suggest that there might be a slight advantage for tests in the modality of vision. Correlations of tests in this modality average 0.35; the one correlation in the modality of hearing is 0.09; the average

---

19 Cf. Chap. VI, p. 45.

20 Millard L. Valentine, Experimental Foundations of General Psychology, Revised Edition, (New York: Rinehart and Company, Inc., 1941), p. 370.

for correlations between modalities (auditory-visual) is 0.27. Correlations of tests involving the use of digits average 0.35, which is slightly higher than the average for all correlations. None of these results suggest statistical significance, but there are many indications of a large field for further study and experimentation.

At this point in the experimentation, it would have been of definite interest to explore the aspects of space relations with respect to the new test and other tests which are designed to test this factor. After due consideration, it was regretfully decided that time did not permit the opening of this approach, at that time. This, too, is an area in which further experimental work may well be carried out.

It was also hoped that certain evidence as to the correlations between this test and some measure of intelligence might have been offered at the conclusion of the report of the experimental work. At the time of writing, the data are being collected, but it will not be available in time to include it in this report. It would have been of considerable interest to compare these results with the many published accounts of similar experimental studies. Here, again, is an area for further research. Although there is a good deal of published material, there is anything but

unanimity of opinion expressed.

This concludes the experimental and statistical evidence which can be offered with respect to the newly developed test of immediate memory. In the final chapter, an attempt will be made at the criticism and final evaluation of the test. It will also include a general summary of the entire experimental procedure.

CHAPTER VII

SUMMARY, PROBLEMS AND CONCLUSIONS

Starting from a desire to investigate the problem of creative thought, a completely modified course of action has had to be adopted. The original problem, with all its interesting questions and areas of investigation has barely been touched and the entire field remains open for further investigation. It is hoped that the present effort will have contributed a useful instrument for further work upon this particular psychological problem.

Preliminary survey of the problem led to the conclusion that there was not a satisfactory instrument for such an investigation. Further study indicated the necessity for designing the necessary equipment with which to carry out the task. When, as was the case in the present instance, the equipment to be designed is a test for psychological use, the secondary problem soon becomes a major problem, in its own right. It was decided that the field of immediate memory would be well suited to the testing of certain hypotheses with respect to a postulated organizational process. Since this process was thought, in certain cases, at least, to occur at a level below that of consciousness, it was necessary that

the instrument should have the capacity for exploration of the problem at this level.

A survey of the available literature with respect to memory, in general, and immediate memory, in particular, revealed what was, to the experimenter, a somewhat surprising fact that there was relatively little definite knowledge relating to one of the most common of mental phenomena. It also revealed that there was not a test instrument that might be expected to yield the required evidence. This set the immediate problem of designing the test, and that has remained the main problem of the present thesis. The problem of the suitability of the test for the specific purpose for which it was designed has, however, remained in the picture and has been treated whenever possible, in the course of the experimentation. In addition, certain other problems have been encountered in the course of the study. These have been indicated where possible and whenever they were considered relevant, or important enough in their own right, to merit the space.

The problem has been carried through essentially four steps, up to the present time. The first step was that of the designing of the sort of test, with respect to material and presentation, that might be expected to serve the purpose for which it was required. It involved purchase,

or manufacture, of the particular material needed for the experimental work. All this procedure has been described at length in the body of the thesis.

The next step involved the preliminary trial of a portion of the newly designed material upon a small group of nine subjects. Several purposes were served at this stage of the experimentation; mechanical faults in material and techniques were detected and, insofar as possible, corrected; the experimenter had an opportunity to observe the material in action and to form his own judgments as to the changes that should be made; certain tentative conclusions might be drawn as to the suitability of the material for the projected purpose; and, finally, a general decision might be made as to the advisability of continuation of the research along the projected line of attack, or, if indicated, along another more productive line of approach.

Results of this preliminary trial run seemed sufficiently positive that continuation along the same approach was deemed advisable. The material had been found to be adequate from the point of view of the mechanics of presentation. There had been reasonably consistent differences in the means of the scores resulting from the different types of material employed in the test. There were differences in scores as between individuals. The smallness of the group,

the limited nature of the material used, and certain other factors, argued against the expectation of statistically significant results at this stage, but general trends seemed to be clearly indicated.

The third stage involved the testing of the entire body of material that had been devised. This particular experimental procedure had, as its main objective, the selection of a suitable body of material, from the larger quantity available, for the final form of the test of immediate memory. At this stage, it was reasonable to expect that, with the larger body of material, and with thirty-six subjects, certain statistically significant results might be obtained, with respect to some of the problems involved. This was proven in the course of the experimental work.

Statistical evidence was obtained with respect to the significance of the variance between the scores from the different types of material. This provided confirmation of the suitability of the material for the testing of the original hypothesis. The absolute differences between group means for different types of material appeared again and were relatively consistent. This was a further indication of the suitability of the instrument, particularly in view of the fact that these differences either

were, or closely approached being statistically significant. Certain limitations of the experimental situation suggested that the obtained figures might be considered as satisfactory and that no change of direction needed to occur. In addition, sufficient statistical data were derived to make possible the final choice of material for the new test.

At this stage of the experimentation, subjective verbal reports were received from the subjects with respect to the level of consciousness at which the correct patterning of the material became evident to them. It is admitted that there is no statistical evidence to offer with respect to this matter, but it is possible to make the following statement. There has been no subjective report of any consciousness of the correct pattern of lines before it appeared in the reproduction of the lines upon paper, for any group of lines presented for the first time. This would strongly suggest that the increments between Nonsense, Gestalt and Meaningful plates are due to a factor which is not evident to the subjects. The original hypothesis of an organizational factor, operative at a level below that of consciousness, is still quite open to further investigation.

It might be mentioned, in referring to this matter

of organization, that certain internal evidence within the plates, when they were being checked upon the answer sheets, suggested the possibility that certain subjects, realizing that some of the plates had organized patterns, consciously attempted to find balanced patterns in other plates. In general, there seemed to be no advantage from such procedures. Many lines, originally reproduced correctly, had been scratched out and entered wrongly. Again, no statistical evidence can be offered, but it is the firm belief of the experimenter that as much, in terms of test score, was lost by such procedure as was gained.

However, there is a possibility that the purely Gestalt concepts of tendency toward a closure, toward balance, and, in general, the good gestalt, has an important bearing upon the results. This might provide a clue to the somewhat unique position of the Gestalt plates in the matter of correlations. This is another possible direction of research with this same material.

With the final arrangement of the items for the test concluded, there remained one further step to be undertaken. This involved the trial of the test, in its complete form, along with other tests of immediate memory and a retest of itself. Much valuable data were acquired at this stage. For the third time, there were relatively

consistent differences between the group means for types of material. One of these differences was barely significant from a statistical point of view, but this was largely due to a shift in the relative position of the Gestalt mean with respect to the other two means. There were statistically significant differences in individual total scores. The test, in terms of each of the types of material, as well as in its entirety, had yielded distributions of scores which did not differ significantly from the normal distribution. Finally, the reliability of the test, as a whole, had been established at a satisfactory level. It was now felt that there was ample justification for stating that a new test of immediate memory had been devised. There was good grounds for supposition that this new test might prove satisfactory for the purpose for which it had been designed.

In the course of the investigation, certain problems had been indicated, which seemed to warrant further study. One of these relates to the relationship of the Gestalt material to the other types of material within the test. There is a consistently lower correlation between the scores for Gestalt plates and the scores of either of the other types of plates than between Meaningful and Nonsense plates. This may indicate that there is another factor

entering into the problem, either with respect to the Gestalt plates, or as a common factor to the other two types. The previously mentioned tendency to a good gestalt may be another possible line of approach. In any event, the problem has been indicated and there has been no obvious solution in the course of this experimentation.

The entire question of the various correlations of different types of tests of immediate memory with one another has been touched upon. Some slight indications have been found which might lead to fruitful investigation. The question of relationships between tests of immediate memory and other psychological tests has been indicated, but not touched upon in this research.

At this point, it would seem fitting to offer certain suggestions with respect to further use of this test for experimental work. In its present form, it is unsuited for rapid presentation, and any operator would require a large amount of practice to handle the material smoothly. The entire test should be reproduced upon film strip for projection. It would then be possible to design an apparatus to ensure accurate timing for the presentation of individual lines. This would make the test relatively simple for an inexperienced administrator to conduct. A

less desirable alternative suggestion would be the reproduction of the test upon slides for projection.

To eliminate the unduly low score for the first plate, mentioned on Page 47, and to ensure complete familiarity with the test procedure, it is suggested that a sample plate should be designed. This would be presented at the beginning of the test, before the test proper was undertaken. Details of this would need to be worked out, but it is suggested that a plate of the Nonsense type might prove most suitable for this purpose.

It is also suggested that the test has some very definite advantages with respect to its adaptation as a test of learning. It seems probable that there is less possibility of disturbing associative values being attached to these single lines then to the usual nonsense syllables and other types of material usually employed for this purpose. It is hoped that the test may be adapted to this purpose and that some of the usual learning experiments may be conducted in an attempt to determine if the results are the same as with other types of material.

In its present form, the test has been used with a very restricted population. It will be necessary to experiment with it upon a much wider scale before any claims can be made as to its suitability for a general

population. It is quite probable that, in its present form, it would prove much too difficult for use with children. However, this, along with all the other questions and problems that have been mentioned in this concluding chapter, will have to be left for further experimental work.

It now becomes possible to refer to the hypothesis stated at the end of Chapter III, and make the following statement:

> 'A suitable selection of the above-mentioned material <u>does</u>, when administered serially, in the modality of vision, and reproduced with pencil upon paper, measure individual differences in immediate memory. It <u>does</u>, at the same time, yield statistically significant group differences in the number of lines remembered in the various types of material. Further, there <u>is</u> descending average number of lines remembered between Meaningful and Gestalt and between Gestalt and Nonsense.'

No good reason has been found to reject the hypothesis.

BIBLIOGRAPHY

Barrett, James Francis, Elements of Psychology. Milwaukee: Bruce Publishing Company, 1931.

Bartlett, F. C., Remembering; a Study in Experimental and Social Psychology. New York: MacMillan Co., 1932. (Cited in Psychological Abstract 7; 1933.

Boring, E. G., H. Langfeld and H. Weld, Foundations of Psychology. New York: John Wiley and Sons, Inc. 1934, 1946.

Brennan, Robert Edward, General Psychology. New York: MacMillan Company, 1937.

Bridges, James Winfred, Psychology, Normal and Abnormal. New York: D. Appleton and Company, 1932.

Carlson, H. B., and H. A. Carr, "Roto and Logical Recognition Memory", J. Exper. Psychol., 26, 1940; 199-200.

Collins, Mary, and James Drever, Experimental Psychology. London: Methven and Company, 36 Essex St., W.C., 1926.

Delay, Jean, "Les Trois Memoires," J. Psychol. norm. path., 1940; 41; 37-8, 374-393. (Cited in Psychological Abstracts; 21, 1947.)

Ellis, Robert Sidney, The Psychology of Individual Differences. New York: D. Appleton and Company, 1928.

Freeman, Ellis, Principles of General Psychology. New York: Henry Holt and Company, 1939.

Garrett, Henry E., and M. R. Schneck, Psychological Tests, Methods and Results. New York: Harper and Brothers, Publishers, 1933.

Gray, J. Stanley et al., Psychology in Use. New York: American Book Company, 1941.

Johnson, Palmer O., Statistical Methods in Research. New York: Prentice-Hall, Inc., 1949.

Moore, Dom Thomas Verner, Cognitive Psychology. New York: J. B. Lippincott Company, 1939.

Murphy, Gardner, Historical Introduction to Modern Psychology. New York: Harcourt, Brace and Company, 1932.

Petermann, Bruno, The Gestalt Theory and the Problem of Configuration. London: Kegan Paul, Trench, Trubner and Company, Ltd., Broadway House, Carter Lane, E.C., 1932.

Rapaport, David, Diagnostic Psychological Testing, Vol. I., Menninger Clinic Monograph Series, No. 3. Chicago: The Year Book Publishers, Inc., 304 South Dearborn St., 1945.

Spearman, Carl, Psychology Down the Ages, Vol. II. London: MacMillan and Company, Ltd., St. Martin's Street, 1937.

Sully, James, Outlines of Psychology. London: Longmans, Green and Company, 1885.

Thurstone, L. L., "Primary Mental Abilities", Psychometric Monographs, No. 1. Chicago: University of Chicago Press, 1938.

Valentine, Willard L., Experimental Foundations of General Psychology, Revised Edition. New York: Rinehart and Company, Inc., 1941.

Woodworth, Robert S., Experimental Psychology. New York: Henry Holt and Company, 1938.

APPENDIX A

TABLE I

SERIAL ORDER OF PRESENTATION
OF LINES TO FORM VARIOUS PLATES

M1A	51	13	55	23	19	14	22	56	20
M1B	20	13	23	22	55	19	14	56	51
M1C	20	19	13	14	55	56	51	23	22
M2A	18	49	55	19	52	21	54	16	14
M2B	49	55	52	19	16	14	21	18	54
M2C	49	14	19	18	55	54	21	16	52
M3A	3	15	17	53	22	24	18	20	49
M3B	3	17	15	53	49	24	20	18	22
M3C	20	17	3	22	18	49	53	24	15
G1A	46	51	52	45	43	53	22	54	44
G1B	43	52	22	54	45	44	46	53	51
G1C	45	46	53	52	43	44	51	54	22
G2A	13	51	24	56	14	45	9	41	7
G2B	45	9	51	24	41	7	56	14	13
G2C	7	56	51	45	13	14	9	24	41
G3A	13	51	23	54	16	11	47	41	7
G3B	16	41	7	51	23	13	54	47	11
G3C	7	16	23	51	47	54	41	13	11
N1A	27	20	49	21	23	56	16	4	30
N1B	56	16	23	21	27	30	4	49	20
N1C	23	20	27	16	21	30	49	4	56
N2A	45	4	14	52	54	8	24	49	31
N2B	52	45	31	49	4	14	24	54	8
N2C	31	4	45	54	49	14	52	8	24
N3A	42	18	56	4	50	9	17	15	31
N3B	4	9	17	42	18	31	15	56	50
N3C	31	4	17	56	9	42	15	18	50

TABLE II

PRELIMINARY TEST-RUN RAW DATA
SEPTEMBER, 1949

SUBJ.	M1B			G2B			N3B			G3B			N1B			M2B			N2B			M3B			G1B		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	3	6	9	5	5	6	3	6	8	5	4	6	4	6	7	8	8	9	5	6	8	7	8	9	9	7	8
2	3	4	9	6	3	6	2	5	4	5	2	5	7	6	4	6	8	9	7	8	9	6	5	9	7	9	9
3	3	4	6	4	4	3	2	7	8	3	4	6	3	4	5	7	9	8	2	4	4	7	6	6	3	7	6
4	1	5	6	4	5	8	3	7	6	7	9	9	5	5	9	8	9	9	4	9	9	8	9	9	2	9	9
5	1	2	1	5	4	4	2	5	6	3	3	3	2	7	9	4	8	9	6	8	9	1	7	9	4	5	9
6	1	4	5	2	6	7	2	4	4	4	3	8	4	7	8	9	8	9	6	6	7	8	7	7	5	6	2
7	5	1	3	5	5	3	4	3	1	4	2	2	4	3	5	6	5	9	4	6	8	2	7	8	2	6	9
8	3	3	5	6	4	7	3	4	4	6	7	9	6	7	7	9	9	8	6	9	9	7	9	9	4	6	9
9	6	5	5	3	4	4	3	3	3	2	6	7	4	5	5	4	7	6	3	4	3	5	7	7	5	6	5

READ TABLE: Subject 4, on plate N3, difficulty order B, correctly reproduced 3 lines on Trial 1, 7 lines on Trial 2, and 6 lines on Trial 3; etc.

TABLE III

MEANS AND STANDARD DEVIATIONS
PRELIMINARY TEST-RUN MATERIAL
(FIRST PRESENTATIONS, ONLY)

M1B	2.89	1.67
G2B	4.44	1.26
N3B	2.67	0.67
G3B	4.33	1.49
N1B	4.33	1.42
M2B	6.78	1.81
N2B	4.78	1.55
M3B	5.67	2.40
G1B	4.56	2.16
ALL 'M'	5.11	2.57
ALL 'G'	4.44	1.68
ALL 'N'	3.93	1.56

TABLE IV

DIFFERENCES OF MEANS
PRELIMINARY TRIAL

	Mean	S.D.
Meaningful	15.33	3.84
Gestalt	13.33	3.32
Nonsense	11.78	2.60

	"r"	Diff. of means	"t" of d"t"	Significance
Meaningful-Gestalt	0.19	2.00	1.24	.3 > p > .2
Gestalt-Nonsense	0.24	1.55	1.26	.3 > p > .2
Meaningful-Nonsense	0.71	3.55	3.94	.01 > p > .001

TABLE V

MEANS FOR FIRST
AND SUBSEQUENT PRESENTATIONS OF ALL PLATES
PRELIMINARY TRIAL

Plate	First Pres'n	Second Pres'n	Third Pres'n
M1B	2.89	3.78	5.44
G2B	4.44	4.44	5.33
N3B	2.67	4.89	4.89
G3B	4.33	4.44	6.11
N1B	4.33	5.56	6.56
M2B	6.78	7.89	8.44
N2B	4.78	6.67	7.33
M3B	5.67	7.22	8.11
G1B	4.56	6.78	7.33

TABLE VI

SERIAL ORDER
OF PRESENTATION OF PLATES TO GROUPS
EXPERIMENTAL TRIALS

SUB TEST I			SUB TEST II			SUB TEST III		
GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8	GROUP 9
M1A	G3B	N2C	G2B	N1C	M3A	N3C	M2A	G1B
M2B	G1C	N3A	G3C	N2A	M1B	N1A	M3B	G2C
M3C	G2A	N1B	G1A	N3B	M2C	N2B	M1C	G3A
G2A	N1B	M3C	N3B	M2C	G1A	M1C	G3A	N2B
G3B	N2C	M1A	N1C	M3A	G2B	M2A	G1B	N3C
G1C	N3A	M2B	N2A	M1B	G3C	M3B	G2C	N1A
N3A	M2B	G1C	M1B	G3C	N2A	G2C	N1A	M3B
N1B	M3C	G2A	M2C	G1A	N3B	G3A	N2B	M1C
N2C	M1A	G3B	M3A	G2B	N1C	G1B	N3C	M2A

TABLE VII

EXPERIMENTAL TRIALS RAW DATA
GROUPS 1, 2 & 3

	M1A			M2B			M3C			G1C			G2A			G3B			N1B			N2C			N3A		
SUBJ.	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	6	6	8	7	7	7	7	8	8	6	4	8	5	7	9	6	7	9	4	6	9	6	7	9	7	7	9
2	2	2	6	7	6	8	9	9	9	4	9	9	6	7	8	5	8	9	2	1	9	6	2	3	7	7	8
3	7	6	8	9	8	8	7	9	9	9	5	9	9	8	9	7	9	9	4	4	9	5	6	6	6	6	9
4	3	9	7	4	7	8	7	9	9	9	4	9	9	9	9	9	9	9	2	4	6	5	8	9	6	6	9
5	7	6	6	6	8	8	6	9	9	7	4	9	9	8	9	7	9	9	7	6	9	7	7	9	7	7	9
6	8	9	9	7	8	9	7	9	9	9	7	9	9	9	9	9	9	9	7	9	9	6	9	9	6	9	9
7	5	9	9	7	9	9	8	9	9	1	6	9	3	4	9	3	4	9	2	7	9	6	9	9	7	8	9
8	6	9	9	7	9	9	7	9	9	3	8	9	3	7	9	6	8	9	5	3	9	5	6	9	7	8	9
9	3	5	9	6	7	9	7	8	9	5	6	9	4	2	9	3	3	9	5	1	7	5	7	9	6	7	9
10	7	7	8	6	8	9	7	9	9	5	9	9	5	6	9	8	3	9	5	7	7	7	8	9	8	9	9
11	8	9	9	7	8	9	8	9	9	3	6	9	3	8	9	4	5	9	4	7	7	5	9	9	9	9	9
12	7	9	9	8	9	9	9	9	9	5	7	9	5	2	9	4	6	9	5	8	9	9	9	9	7	9	9

TABLE VII. (Cont.)

EXPERIMENTAL TRIALS RAW DATA
GROUPS 4, 5 &6.

	M1B			M2C			M3A			G1A			G2B			G3C			N1C			N2A			N3B		
SUBJ.	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
13	7	8	9	5	7	9	7	9	9	1	7	9	3	2	7	6	8	9	3	6	9	4	9	9	3	6	7
14	5	9	9	6	9	9	6	8	8	8	9	9	8	9	9	9	9	9	6	4	7	4	9	9	5	7	8
15	6	9	9	7	9	9	9	9	9	2	5	6	7	7	9	7	9	9	4	8	8	7	9	9	6	9	9
16	6	7	9	8	9	9	8	8	9	9	9	9	6	7	9	9	9	9	4	5	8	2	6	9	5	8	9
17	3	5	7	2	2	8	7	7	8	9	6	5	5	5	6	2	4	9	3	2	5	3	4	6	3	2	6
18	6	7	9	4	8	9	7	9	9	9	5	5	6	7	8	4	6	9	8	9	9	3	5	8			
19	6	7	7	5	6	6	6	5	6	3	5	5	4	5	5	3	4	9	2	1	2	4	3	6			
20	4	7	9	2	4	5	6	7	8	4	8	8	4	7	7	6	9	9	4	6	4	5	7	8			
21	5	5	5	6	6	8	7	7	8	3	4	4	4	5	6	6	3	6	3	5	6	4	3	3			
22	2	6	6	5	6	7	3	7	7	5	6	7	6	7	9	9	3	9	3	5	6	2	5	9			
23	7	8	9	3	5	9	8	8	8	8	9	9	2	6	5	7	9	9	3	3	6	3	4	8			
24	3	7	9	5	9	9	7	8	9	9	9	9	5	6	7	7	9	9	3	4	6	4	8	9			

TABLE VII. (Cont.)

EXPERIMENTAL TRIALS RAW DATA
GROUPS 7, 8 & 9.

	M1C			M2A			M3B			G1B			G2C			G3A			N1A			N2B			N3C		
SUBJ.	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
25	9	9	9	4	7	9	3	5	9	9	9	9	7	4	5	7	9	9	5	6	6	3	5	5	3	3	4
26	6	7	9	7	9	9	6	7	9	0	9	9	3	6	9	3	9	9	6	6	8	5	9	9	3	5	6
27	5	9	9	6	9	9	6	8	9	4	9	9	2	7	8	8	9	9	3	5	6	8	9	9	3	4	7
28	5	8	9	9	9	9	9	9	9	9	9	9	5	5	8	6	8	9	6	6	8	5	5	8	4	4	5
29	4	6	7	6	8	8	6	7	9	4	2	4	4	5	5	4	5	5	6	5	4	3	7	8	2	4	6
30	6	6	8	3	4	6	3	6	7	2	2	4	3	4	6	5	6	9	4	4	6	3	6	6	2	5	8
31	4	7	9	9	9	9	3	6	8	7	9	9	4	6	6	2	6	7	4	9	8	4	7	9	5	6	7
32	7	9	9	6	7	9	7	7	5	5	3	8	6	7	9	8	9	6	4	6	7	3	8	6	3	8	3
33	5	5	5	2	4	7	3	5	7	1	3	6	5	5	4	6	4	3	4	2	3	3	4	5	1	2	4
34	7	9	9	5	5	8	7	6	6	2	6	5	3	4	4	5	7	6	4	7	7	4	9	9	4	5	4
35	7	7	9	5	5	9	7	8	9	4	5	6	2	3	5	5	6	7	7	9	9	5	6	8	4	5	7
36	4	3	4	4	4	3	6	6	6	2	5	2	4	5	6	3	5	5	4	6	8	3	4	5	2	2	4

TABLE VIII

MEANS AND STANDARD DEVIATIONS
FOR FIRST PRESENTATIONS AT EXPERIMENTAL TRIALS

	Mean	S.D.		Mean	S.D.		Mean	S.D.
M1A	5.75	1.96						
M1B	5.00	1.58	M1	5.50	1.73			
M1C	5.75	1.48						
M2A	5.50	2.06						
M2B	6.75	1.16	M2	5.69	1.88	M	5.92	1.85
M2C	4.83	1.77						
M3A	6.75	1.42						
M3B	5.50	1.94	M3	6.56	1.76			
M3C	7.42	1.26						
G1A	5.83	3.00						
G1B	4.08	2.84	G1	5.03	2.91			
G1C	5.17	2.61						
G2A	6.17	1.28						
G2B	4.92	1.60	G2	5.03	1.71	G	5.16	2.27
G2C	4.00	1.47						
G3A	5.25	1.74						
G3B	4.17	1.82	G3	5.42	1.99			
G3C	6.83	1.40						
N1A	4.67	1.25						
N1B	4.17	1.82	N1	4.11	1.47			
N1C	3.50	0.96						
N2A	4.25	1.79						
N2B	4.17	1.40	N2	4.19	1.65	N	4.19	1.58
N2C	4.17	1.72						
N3A	6.00	0.91						
N3B	3.83	1.07	N3	4.28	1.63			
N3C	3.00	1.08						
					ALL PLATES		5.09	2.04

TABLE IX

INDIVIDUAL TOTALS
FOR EXPERIMENTAL TRIALS

Subj.	Meaningful	Gestalt	Nonsense	Total
1	20	17	17	54
2	18	15	9	42
3	23	23	13	59
4	14	22	11	47
5	21	17	20	58
6	22	14	13	49
7	20	10	14	44
8	20	14	16	50
9	13	17	11	41
10	21	8	19	48
11	23	12	17	52
12	24	17	12	53
13	19	10	10	39
14	17	25	15	57
15	22	16	17	55
16	22	24	11	57
17	12	19	8	39
18	17	20	15	52
19	17	12	9	38
20	12	14	13	39
21	18	13	12	43
22	10	20	8	38
23	18	17	9	44
24	15	21	12	48
25	16	23	11	50
26	19	6	14	39
27	17	14	14	45
28	23	20	15	58
29	16	12	11	39
30	12	10	9	31
31	16	13	13	42
32	20	19	10	49
33	10	11	8	29
34	19	10	12	41
35	19	11	16	46
36	14	11	9	34

TABLE XII

RELIABILITY COEFFICIENTS
FROM FIRST AND SECOND PRESENTATIONS
EXPERIMENTAL TRIALS

	Order A	Order B	Order C
M1	0.76	0.54	0.64
M2	0.84	0.48	0.88
M3	0.49	0.80	0.36
G1	0.67	0.38	0.33
G2	0.19	0.65	0.57
G3	0.48	0.64	0.70
N1	0.42	0.44	0.27
N2	0.70	0.42	0.71
N3	0.59	0.39	0.53
All "M"			0.73
All "G"			0.52
All "N"			0.57
All plates			0.62

TABLE XIII

CONDENSED DATA
FOR PLATES SELECTED
FOR FINAL TEST FORM

	1'st Pres'n		2'nd Pres'n		
	Mean	S.D.	Mean	S.D.	"r"
M1A	5.75	1.96	7.17	2.15	0.76
M2A	5.50	2.06	6.67	2.05	0.84
M3B	5.50	1.94	6.67	1.18	0.80
G1C	5.17	2.61	5.83	2.82	0.33
G2B	4.92	1.60	6.00	1.53	0.65
G3A	5.25	1.74	6.83	1.95	0.48
N1B	4.17	1.82	5.75	1.48	0.44
N2C	4.17	1.72	6.08	1.55	0.71
N3B	3.83	1.07	5.58	2.02	0.39

TABLE XIV

RAW DATA FROM TEST-RETEST

SUBJ.	M1	M2	M3	M	G1	G2	G3	G	N1	N2	N3	N	TOT.
1	4	5	3	12	4	6	4	14	2	4	1	7	33
2	5	7	8	20	6	3	6	15	4	6	6	16	51
3	1	4	1	6	2	3	6	11	3	4	1	8	25
4	3	4	4	11	1	4	4	9	2	4	2	8	28
5	6	6	9	21	3	6	4	13	6	3	6	15	49
6	6	5	5	16	4	5	2	11	3	1	2	6	33
7	4	3	7	14	7	5	5	17	2	3	6	11	42
8	2	2	5	9	2	5	0	7	2	0	1	3	19
9	3	5	5	13	4	4	5	13	3	4	6	13	39
10	4	6	8	18	2	2	3	7	3	6	4	13	38
11	4	9	6	19	5	6	9	20	6	4	7	17	56
12	4	5	8	17	4	2	2	8	1	0	4	5	30
13	4	6	7	17	2	6	5	13	3	2	4	9	39
14	2	7	7	16	6	7	6	19	3	5	6	14	49
15	3	3	5	11	2	4	6	12	1	4	1	6	29
16	4	8	4	16	2	8	5	15	2	3	5	10.	41
17	4	8	8	20	5	3	6	14	4	4	4	12	46
18	5	7	5	17	5	5	4	14	4	4	4	12	43
19	1	6	5	12	3	4	3	10	4	3	5	12	34
20	6	8	8	22	5	5	6	16	3	3	4	10	48
21	9	5	8	22	2	5	5	12	6	4	9	19	53
22	8	6	5	19	5	2	1	8	6	3	5	14	41

RETEST

1	6	4	2	12	5	0	3	8	1	2	2	5	25
2	9	7	7	23	7	6	5	18	6	6	6	18	59
3	4	4	3	11	3	5	4	12	5	5	2	12	35
4	2	2	4	8	2	8	5	15	5	3	4	12	35
5	7	9	7	23	7	8	7	22	4	3	7	14	59
6	1	9	7	17	5	5	4	14	4	3	8	15	46
7	6	7	8	21	6	5	5	16	4	6	7	17	54
8	2	8	4	14	1	6	1	8	3	2	2	7	29
9	9	6	6	21	3	5	2	10	2	4	5	11	42
10	6	8	8	22	2	4	5	11	6	4	7	17	50
11	9	9	8	26	9	5	9	23	4	6	8	18	67
12	9	9	8	26	5	4	6	15	3	2	3	8	49
13	6	9	6	21	4	4	4	12	2	5	5	12	45
14	6	9	8	23	8	7	9	24	4	5	4	13	60
15	6	9	8	23	1	2	6	9	4	5	2	11	43

TABLE XV

RAW DATA
FROM IMMEDIATE MEMORY TESTS

Subj.	Digits Oral		"M" Factor	Digits Visual	
	F'w'd	B'w'd		F'w'd	B'w'd
1	6	7	6	6	6
2	7	5	19	8	7
3	7	5	10	7	6
4	5	7	7	7	6
5	8	8	20	8	7
6	8	8	17	8	7
7	8	6	20	7	7
8	7	6	14	5	5
9	8	6	17	6	6
10	8	6	20	7	6
11	7	5	14	6	7
12	9	7	11	7	8
13	6	6	8	4	6
14	9	3	13	8	8
15	7	3	6	8	7
16					
17	6	5	14	4	6
18	9	7	20	9	8
19	8	6	10	9	8
20	7	6	15	8	8
21	8	7	17	7	7
22	6	5	15	6	5

TABLE XVI

TEST-RETEST
MEANS AND STANDARD DEVIATIONS

	Test Subj. 1-22		Test Subj. 1-15		Retest Subj. 1-15	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
M1	4.18	1.95	3.67	1.35	5.87	2.55
M2	5.68	1.77	5.13	1.75	7.27	2.21
M3	5.95	1.96	5.87	2.10	6.27	1.99
G1	3.68	1.74	3.60	1.74	4.53	2.45
G2	4.55	1.59	4.53	1.50	4.93	2.02
G3	4.41	1.97	4.47	2.09	5.00	2.16
N1	3.32	1.52	2.93	1.44	3.80	1.38
N2	3.36	1.52	3.33	1.81	4.07	1.44
N3	4.23	2.13	3.80	2.20	4.80	2.20
All M	15.82	4.25	14.67	4.14	19.40	5.44
All G	12.64	3.54	12.60	3.88	14.46	5.12
All N	10.91	4.04	10.07	4.23	12.67	3.84
Full Test	39.36	9.50	37.33	10.23	46.53	11.71

TABLE XVII

DIFFERENCES OF MEANS
FINAL/TRIAL

	MEAN	S.D.
Meaningful	15.82	4.26
Gestalt	12.64	3.19
Nonsense	10.91	4.12

	"r"	Diff. of means	"t" of diff.	Significance
Meaningful-Gestalt	0.31	3.18	3.94	.001 > p
Gestalt-Nonsense	0.43	1.73	2.04	.10 > p > .05
Meaningful-Nonsense	0.65	4.91	6.56	.001 > p

TABLE XVIII

CORRELATIONS OF VARIOUS MEMORY TESTS

	Line Test	Digits Oral F'w'd	Digits Oral B'w'd	Memory Factor	Digits Visual F'w'd	Digits Visual B'w'd
Line Test	----	0.19	-0.09	0.51	0.10	0.37
Digits Oral F'w'd	0.19	----	0.09	0.52	0.56	0.66
Digits Oral B'w'd	-0.09	0.09	----	0.26	0.07	0.02
Memory Factor	0.51	0.52	0.26	----	0.24	0.14
Digits Visual F'w'd	0.10	0.56	0.07	0.24	----	0.72
Digits Visual B'w'd	0.37	0.66	0.02	0.14	0.72	----

APPENDIX B

FIGURE I

STANDARD GRID
USED FOR PRESENTATION OF LINES

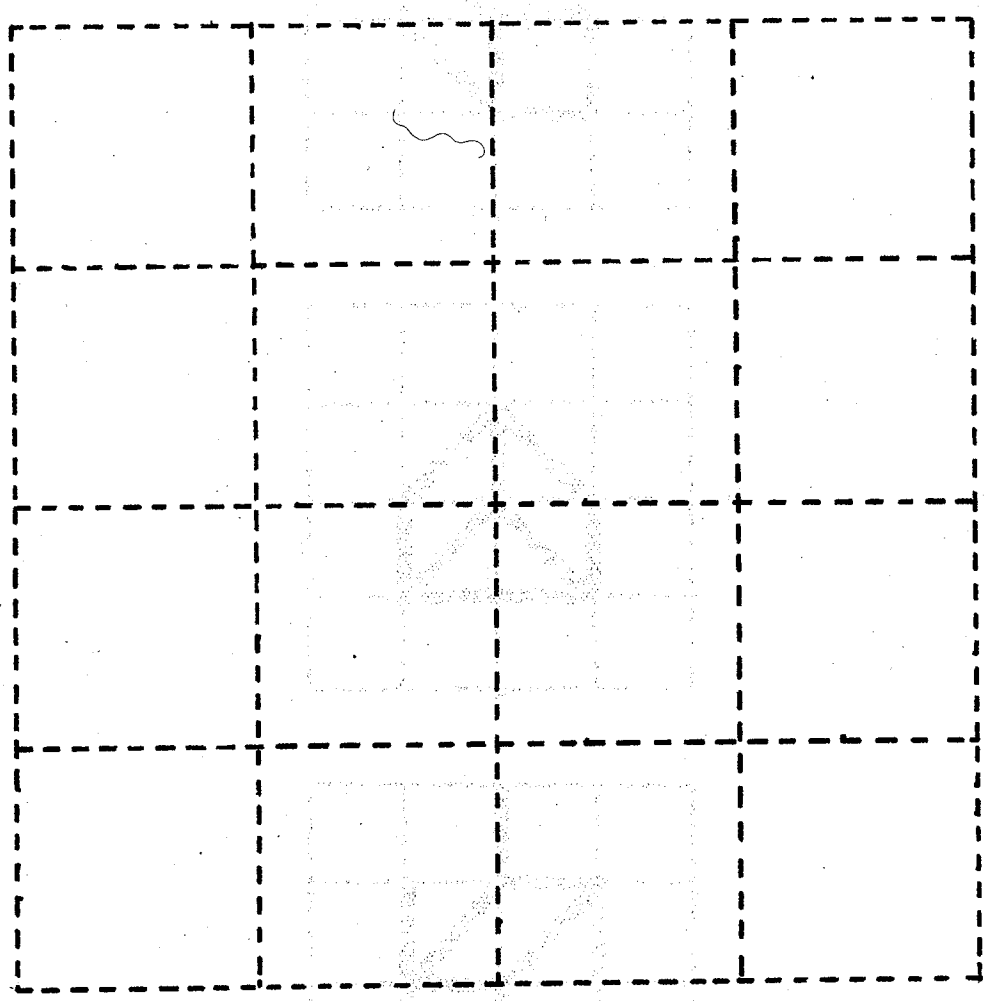
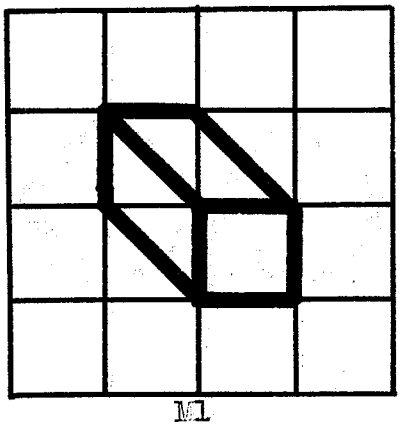
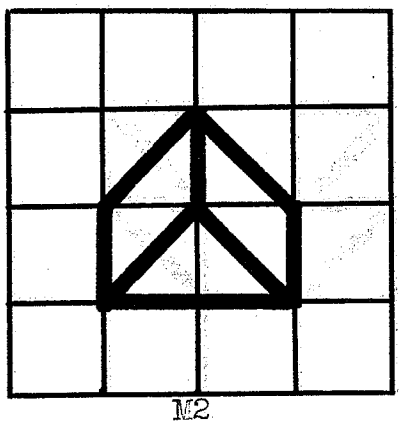


FIGURE II

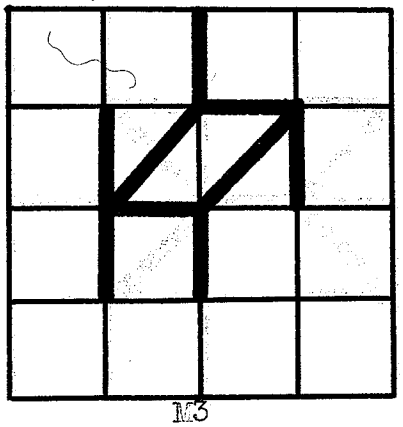
MEANINGFUL PLATES



M1



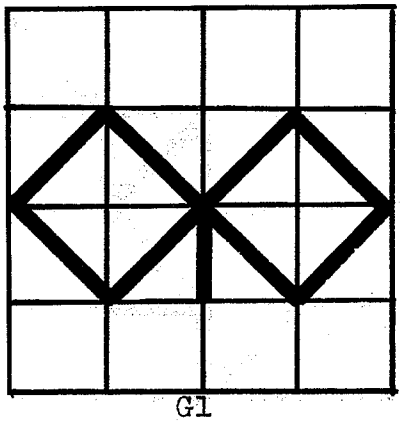
M2



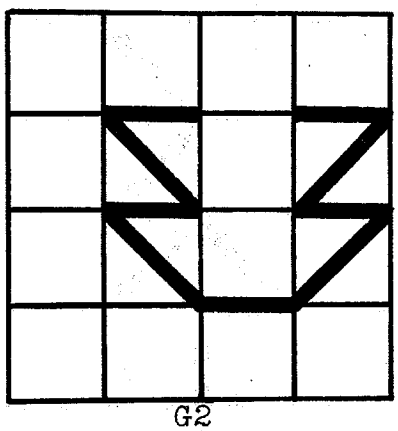
M3

FIGURE III

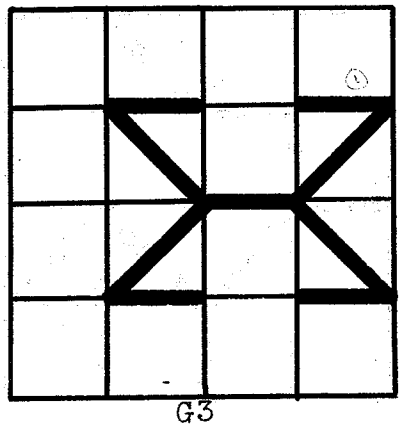
GESTALT PLATES



G1



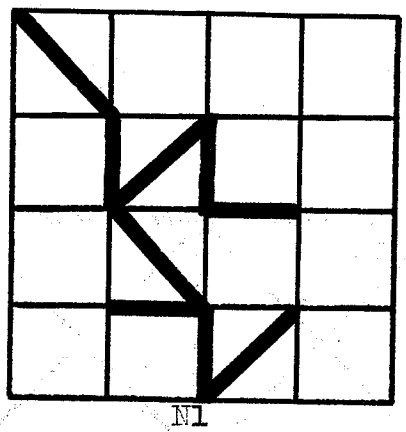
G2



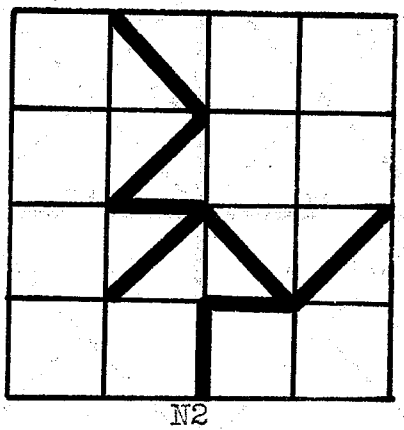
G3

FIGURE IV

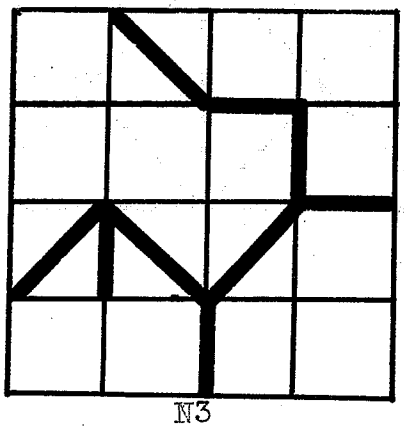
NONSENSE PLATES



N1



N2



N3

FIGURE V

MASTER CHART OF LINES
USED FOR PLATES

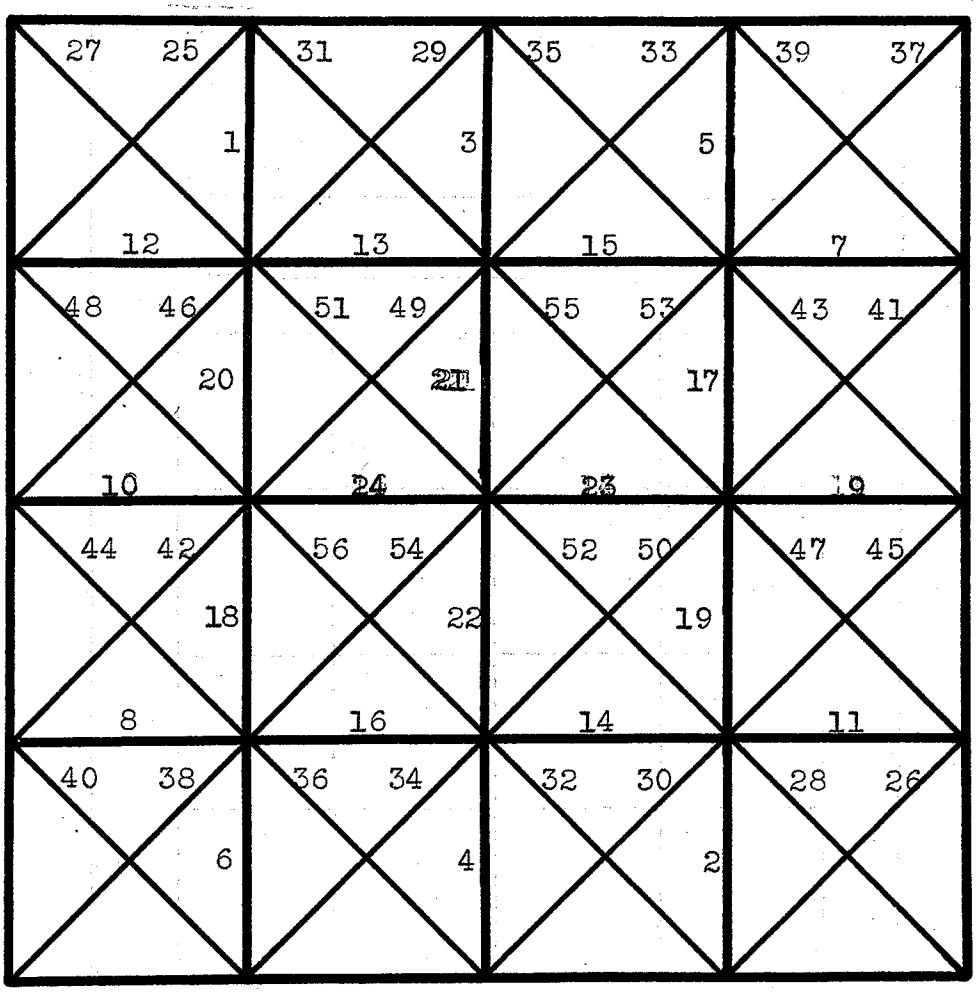


FIGURE VI

INDIVIDUAL RECORD SHEET
FOR REPRODUCTION OF LINES

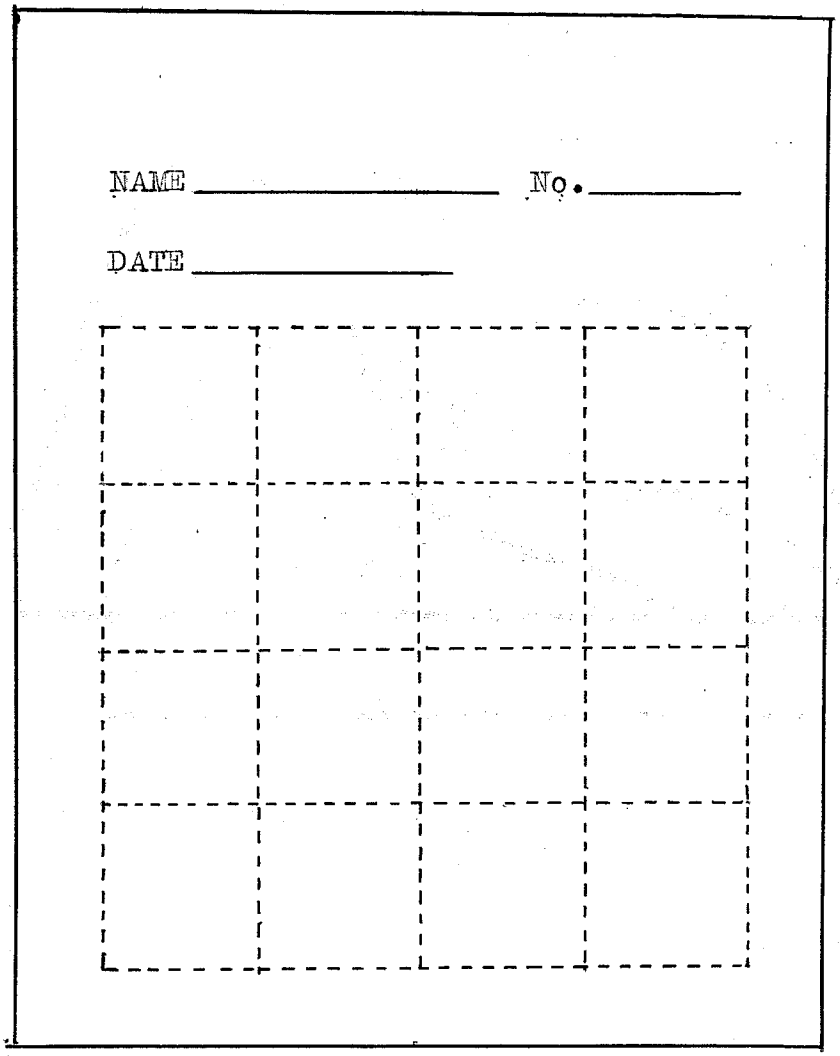


FIGURE VII

DISTRIBUTIONS OF MEANS
FOR FIRST PRESENTATIONS
AT EXPERIMENTAL TRIALS

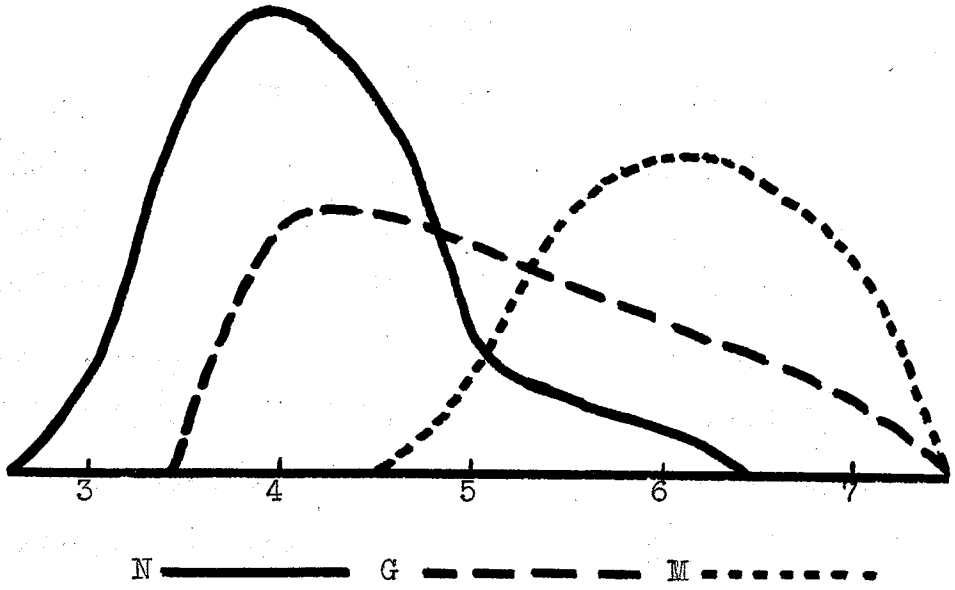


FIGURE VIII

DIGITS FOR ORAL PRESENTATION

Forward		Backward	
6,4,3,9.	(4)	6,2,9.	(3)
4,2,7,3,1.	(5)	3,2,7,9.	(4)
6,1,9,4,7,3.	(6)	1,5,2,8,6.	(5)
5,9,1,7,4,2,8.	(7)	5,3,9,4,1,8.	(6)
5,8,1,9,2,6,4,7.	(8)	8,1,2,9,3,6,5.	(7)
2,7,5,8,6,2,5,8,4.	(9)	9,4,3,7,6,2,5,8.	(8)

FIGURE IX

DIGITS FOR VISUAL PRESENTATION

Forward		Backward	
7,2,8,6.	(4)	4,1,5.	(3)
7,5,8,3,6.	(5)	4,9,6,8.	(4)
3,9,2,4,8,7.	(6)	6,1,8,4,3.	(5)
4,1,7,9,3,8,6.	(7)	7,2,4,8,5,6.	(6)
3,8,2,9,5,1,7,4.	(8)	4,7,3,9,1,2,8.	(7)
7,1,3,9,4,2,5,6,8.	(9)	7,2,8,1,9,6,5,3.	(8)