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 CHAPTER II  
 DESCRIPTION OF THE VARIABLES

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A. Descriptions of the Learning Tasks

The selection or development of learning tasks to investigate the interrelationships among the learning parameters occupied a paramount position in this project. The basic problem was to find learning tasks which on an a priori basis could help to clarify whether human learning was organized in terms of the postulated psychological processes or existing human abilities.

Eleven of the 13 learning tasks were constructed specifically for the study and were pretested on high school subjects and Naval recruits to establish adequate levels of difficulty. The remaining two learning tasks were the Breech Block Performance Test which was developed previously for use in a series of research studies (Allison, 1954; Allison, 1956a; Allison, 1956b) and the Rotary Pursuit Test which was used by permission of the U. S. Air Force.

The learning tasks utilized immediate knowledge of results as the major motivational force and reward. The standard procedure for administering six of the learning tasks, which were presented by 35 mm. black-and-white slides, was to project a stimulus slide using a Revere 888 automatic projector set for seven-second exposure during which time the subject committed himself to a response; and, following a three-second period to change slides, a slide containing both the stimulus and the correct response was projected for seven seconds during which time the subject marked his response right or wrong. After another three-second

change-over period, the next stimulus slide appeared and the procedure continued until a trial was finished. The subject recorded the number of rights and wrongs for the trial and the next trial began. A similar procedure was used for the Knob Code which was presented tactilely and the Sonar Test which was presented auditorily--namely, a stimulus was presented and subject committed himself to a response and was then informed as to the correct response. In the case of the CIC Plotting Test and the Sidewalk Maze, knowledge of results was made available after each trial. The nature of the Rotary Pursuit Test and the two assembly tests enabled a subject at all times to know how well he was performing. Since the learning tasks were administered on a group basis, the subjects tended to compete with each other even though no attempt was made to indicate how well other members of any group were performing.

The descriptions of the learning tasks follow. Samples of those tasks which lend themselves to printed means appear in Appendix A, which also contains the directions for the learning tasks. The numbers preceding each task are the code numbers of the learning parameters associated with each task. As mentioned in Chapter I, the learning parameters are  $c_1$  (average rate of learning),  $c_2$  (early versus late learning), and where appropriate  $c_0$  (initial ability). The learning parameters and method for computing them are presented in Chapter III.

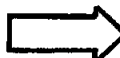

01 ( $c_1$ ) and 14 ( $c_2$ ). Word Code.

Description: Sixteen word-letter pairs, such as DESTROYER - K, ACTION - I, STATIONS - E. The words were selected on the basis of familiarity to a recruit; the letters were selected in order to

minimize misrecognition. Presented by 35 mm. slides as follows: A slide with a stimulus word (DESTROYER) is projected on a screen for seven seconds during which time the subject indicates which response letter he thinks belongs to the stimulus. Following a three-second period to change slides the stimulus word and correct response (DESTROYER - K) are projected for seven seconds which allows ample time for the subject to indicate whether his response is right or wrong. After a three-second delay the second stimulus slide is projected, followed by the appropriate stimulus-response slide. And so on through 16 sets of word-letter pairs per trial. The same word-letter pairs are presented for Trial 2 and succeeding trials with the order of presentation being randomized for each trial.

Number of trials: 9

02 (c<sub>1</sub>) and 15 (c<sub>2</sub>). Spatial Code.

Description: Sixteen symbol-letter pairs, such as  - P,  - Z, C - I. The symbols are standard symbols used by the U. S. Army for reading maps. Presented by 35 mm. black-and-white slides as described above.

Number of trials: 10

03 (c<sub>1</sub>) and 16 (c<sub>2</sub>). Knob Code.

Description: Eight knob-word pairs, such as polygonal-shaped glass knob--AIR, round wooden knob--HEAT, elliptical-shaped, grooved metal knob--WATER. The knobs were the standard household types used on drawers and cabinets. The subject feels a knob located inside a box so constructed as to prevent visual recognition and then indicates on an answer sheet which name he believes to be correct. He next uncovers

the correct answer located on top of the box and marks his answer right or wrong. He then moves to the next station and repeats the procedure for eight knob-word pairs. The order of presentation is randomized for each trial.

Number of trials: 8

04 ( $c_1$ ) and 17 ( $c_2$ ). Sonar.

Description: Twelve sound-word pairs, such as associated with underwater sounds made by drumfish, iceberg, submarine, torpedo, etc. The sounds were obtained from recordings made by the U. S. Navy and used by permission. Presented by tape recording with a 10-second delay between each 10-second sound and identification which allowed the subject time to make a response. Order of presentation is randomized for each trial.

Number of trials: 10

05 ( $c_1$ ) and 18 ( $c_2$ ). Verbal Concept Formation I.

Description: Consists of 16 sets of four words with each set being assigned to one of the code letters A, B, C, or D. Four sets of words belong to each letter; the code letter represents an underlying concept. Concept A is that one of the four words is a number; concept B is that one of the four words is a sport; concept C is that two of the four words are homonyms; concept D is that all four words are units of measurement. The subjects are not required to identify the concepts except by the code letter. Inasmuch as the same 16 sets of words are presented each trial, although randomized in order of presentation, the subject may learn the correct code letters by either

conceptual learning or rote learning. (Informal inquiry later suggested that most subjects found it easier to discover the underlying concept than to apply a rote learning approach.) Presented by 35 mm. black-and-white slides as described above.

Number of trials: 8

06 (c<sub>1</sub>) and 19 (c<sub>2</sub>). Spatial Concept Formation I.

Description: Consists of 16 sets of four, two- and three-dimensional figures with each set being assigned to one of the code letters A, B, C, or D. Four sets of figures belong to each letter; the code letter represents an underlying concept. Concept A is that two of the figures are solids and the other two figures are the vertical two-dimensional projections of them; concept B is that one of the four figures is a circle; concept C is that all four figures could represent three-dimensional objects; concept D is that one of the four figures has a three-pronged, saw-like edge. The same but randomized series of slides is presented each trial and consequently the subject may learn either by a rote learning or a conceptual learning approach. This task parallels closely Verbal Concept Formation I except for stimulus content. Presented by 35 mm. black-and-white slides as described above.

Number of trials: 8

07 (c<sub>1</sub>) and 20 (c<sub>2</sub>). Breech Block Performance Test.

Description: This test is part of a controlled learning situation in which the subject is taught how to assemble the breech block of a 40 mm. antiaircraft gun. The subject views a two-minute sound film describing the step-by-step assembly of the breech block, and is then

given a three-minute trial on the assembly task. The training film-assembly task sequence is repeated six times. The assembly operations consist of a total of nine steps. The number of steps completed constitutes the score for a given trial.

Number of trials: 6

08 (c<sub>1</sub>) and 21 (c<sub>2</sub>). CIC Plotting Test.

Description: A highly simplified version of the plotting activities carried out by a Combat Information Center aboard a ship. For each trial the subject indicates on a modified polar-coordinate-paper grid the positions of 20 objects whose bearings and ranges are presented by a tape recording. The bearings and ranges of the objects vary for each trial. Essentially, the task is one of learning how to plot on polar-coordinate grids. By using carbon paper and a second grid with circles for the correct locations underneath the original the subject can count the number of correct marks after each trial.

Number of trials: 10

09 (c<sub>1</sub>) and 22 (c<sub>2</sub>). Verbal Concept Formation II.

Description: Consists of 16 sets of four words with each set assigned to one of the code letters A, B, C, or D. Four sets of words belong to each letter; the code letter represents an underlying concept. Concept A is that the four words constitute a message; concept B is that two words are synonyms and the other two words are antonyms; concept C is that all four words are objects; concept D is that one of the four words is a weapon. The four concepts are invariant across trials but the word sets are replaced in each trial with alternate sets. This task

therefore closely parallels Verbal Concept Formation I except that the subject has to discover underlying rules for assigning each group of stimulus words to a code letter. Presented by 35 mm. slides as described above.

Number of trials: 9

10 ( $c_1$ ) and 23 ( $c_2$ ). Spatial Concept Formation II.

Description: Consists of 16 sets of four, two-dimensional figures with each set assigned to one of the code letters A, B, C, or D. Four sets of figures belong to each letter; the code letter represents an underlying concept. Concept A is that two of the figures are the same as the other two figures but rotated  $90^\circ$  clockwise; concept B is that three of the figures when properly placed together constitute the fourth figure; concept C is that the four figures represent a design which is bilaterally symmetrical; concept D is that progressive increments to each preceding figure lead to the last figure. The four concepts are invariant across trials but the figure sets are replaced each trial with alternate sets. The task therefore closely parallels Spatial Concept Formation I except that the subject has to discover the underlying rules for assigning each group of stimulus figures to a code letter.

Presented by 35 mm. black-and-white slides as described above.

Number of trials: 9

11 ( $c_1$ ) and 25 ( $c_2$ ). Mecanno Assembly Test.

Description: This learning task was developed by Dr. William G. Mollenkopf to assess the conceptual learning process in a mechanical-motor task. The subject is given instructions by means of 35 mm. slides

and an accompanying sound track as to the basic principles of gear rotation and step-down features. He is then given a five-minute trial to put together various gears, axles, and collars from a Mecanno Set (similar to the American Erector Set) in such a way that for each six turns of a crank a rubber-covered wheel will make one complete turn in the same direction. The subject earns one score point for each of the 12 operations required to complete the assembly task. The instruction-assembly task sequence is repeated five times.

Number of trials: 5

12 ( $c_1$ ), 25 ( $c_2$ ), and 27 ( $c_0$ ). Sidewalk Maze.

Description: This is a simple paper maze on which the subject traces his way along a  $1/4$  inch path which winds hither and yon on an  $8\ 1/2$  x 11 inch sheet of paper. The back side of the maze sheet is printed with carbon material in such a way as to correspond to the path the subject attempts to follow. The carbon underlay comes into contact with a second sheet of paper which contains a distance scale roughly determined in terms of difficulty (i.e., it was considered more difficult to remain within the  $1/4$  inch boundaries of curved sections than straight sections; hence an inch path recorded on a curve section was considered to be equivalent to a longer path on a straight section). For each trial the subject is given 30 seconds to trace through the maze as rapidly as he can. The score, obtained from the carbon tracing on the second sheet, is the distance travelled before a discontinuity or overlap appears on the tracing.



Number of trials: 7

13 ( $c_1$ ), 26 ( $c_2$ ), and 28 ( $c_0$ ). Rotary Pursuit Test.

Description: This is the standard U. S. Air Force Rotary Pursuit Test, Form B (CM803B), for which the subject is required to manipulate a stylus in such a way as to maintain contact with a small silver target set flush with the surface of a disc revolving at 60 rpm. The subject is given 15, 20-second trials separated by 10-second rest periods. The score per trial is the amount of time he maintains contact with the target.

Number of trials: 15

The way in which the learning parameters for the above tasks cluster should aid in the identification of some of the dimensions of human learning. A conventional factor analysis will be applied to the matrix of intercorrelation coefficients for the 28 learning parameters. The resulting factor structure will be rotated to simple structure. After rotation to this criterion, the major factor loadings for the learning tasks are expected to be distributed by one of the two possibilities indicated in Table II-1. The nature of factor analysis is such that other dimensions, perhaps combining these two organizations, may emerge.

#### B. Reference Variables

The second problem considered by this project is concerned with the interrelationship between the learning domain and the human ability domain. Are there factors common to the two domains? If so, what are the relationships between the factors common to each domain? Tucker's

Table II-1. Postulated Dimensions of Human Learning

Learning Task	If organized by psychological processes:			If organized by human abilities:			
	Rote Learning	Conceptual Learning	Motor Learning	Verbal Knowledge	Spatial Visualization	Mechanical Knowledge	Other
Word Code	XX			XX			
Spatial Code	XX				XX		
Knob Code	XX						Ma
Sonar	XX						Ma
Verbal Concept Formation I	X	X		XX			
Spatial Concept Formation I	X	X			XX		
Breech Block Performance Test	X		X			XX	
CIC Plotting Test		X	X		XX		
Meccano Assembly Test		X	X			XX	
Verbal Concept Formation II		XX		XX			
Spatial Concept Formation II		XX			XX		
Sidewalk Maze			XX				PC
Rotary Pursuit			XX				PC

Note: XX = This task is a relatively pure measure of the factor.  
 X = This task involves two factors  
 Ma = Associative Memory.  
 PC = Psychomotor Coordination.

inter-battery method of factor analysis (1958b) will be used to study these questions. This method will create two rotational problems if there are common factors: one to define the inter-battery factors in terms of the learning parameters, and a second to define the inter-battery factors in terms of the reference variables. The inter-battery method will permit the resulting two structures to be studied for similarity by computing the inter-battery factor correlations.

In order to apply the inter-battery method of factor analysis within the conceptual framework discussed in Chapter I, the contents of the learning tests were carefully studied in terms of the amounts of variance of these tests which might be accounted for by previously identified factors. Within reasonable limits, two or more tests of each overlapping factor were included as reference variables. These tests, for the most part, were selected either from the manual edited by French (1954), which is the result of a committee on multiple factor analysis and contains selected tests of well-defined factors; or from French (1951), which is a prior summary of factors contained in achievement and aptitude tests. All of the reference factors have been identified from studies where rotations have been made to the type of simple structure advocated by Thurstone (1947).

The tests or variables which constitute the standard reference variables for this study are listed below and grouped by factors with which they correlate highly. The number preceding each test is the referant code number used throughout this study. The definitions of the factors and the descriptions of the tests have in most cases been taken from French (1951).

Factor Ma: Associative Memory. Defined as the ability to commit pairs of items to memory for short periods of time so that given one member of the pair the other can be recalled or recognized. This is apparently the same factor Kelley (1954) has more recently identified as Rote Memory and defined as the ability to remember bits of unrelated factual materials. Tests containing Factor Ma are listed below.

29. Recognition II

Description: The examinee is read a list of 25 words and indicates in a test list of 50 words, also read, whether or not each word was present in the first list.

Time-limit: Words read at 2-second intervals.

Score: Number right.

30. First Names

Description: The subject examines 20 first and last names and later reproduces the first names associated with the last names.

Time-limit: 90-second practice test; 5 minutes for memory and 3 minutes for test.

Score: Number of first names written correctly.

31. Word-Number

Description: The subject examines 20 word-number pairs and later reproduces the number associated with each word.

Time-limit: 90-second practice test; 5 minutes for memory and 3 minutes for test.

Score: Number of words correctly numbered.

32. Picture-Number

Description: The subject examines 20 pictures of common objects, each paired with a two-digit number and later reproduces the number associated with the picture.

Time-limit: 3 minutes for memory and 3 minutes for test.

Score: Number of pictures correctly numbered.

Factor I: Induction. Defined as the associated abilities involved in finding general concepts that will fit sets of data, the forming and testing of hypotheses. Tests containing Factor I are listed below.

33. Number Series

Description: Each item consists of a series of numbers which follow some rule. The examinee's task is to select the next number which is consistent with the series.

Time-limit: 8 minutes

Score: Number right minus  $1/4$  number wrong.

34. Letter Sets

Description: Each item consists of five groups of letters with four letters per group. Four of the letter groups have some common characteristic which the fifth group does not possess. The examinee selects the one group which does not follow the rule.

Time-limit: 8 minutes

Score: Number right minus  $1/4$  number wrong.

Factor R: General Reasoning. Defined as the ability to carry out the kind of reasoning required in the solution of mathematical problems. The reasoning process appears to be separate from mathematics achievement and tends to be found in a variety of reasoning tests, including non-mathematical ones.

The following tests have been found to contain this factor.

35. Arithmetic

Description: Part of the Navy Basic Test Battery items in this test consist of (a) problems involving routine computation, and (b) verbally stated problems measuring the ability to think in quantitative terms. The Navy Basic Test Battery had been administered prior to this experiment and the test scores were made available by the Navy.

36. Ship Destination

Description: Constructed by Christensen and Guilford, the subject uses knowledge of the position of a ship with respect to a port, wind direction, ocean current, and direction of travel to compute effective distance to port following given rules.

Time-limit: 15 minutes

Score: Number right.

37. Mathematics Aptitude

Description: Classic story problems in mathematics.

Time-limit: 10 minutes

Score: Number right minus  $1/4$  number wrong.

Factor D: Deduction. Defined as the ability to reason from given premises to their necessary conclusions, as perhaps best illustrated in syllogistic tests. The following tests contain this factor.

38. False Premises

Description: Constructed by Thurstone, the subjects are presented with formal syllogisms having certain nonsense words so that they cannot be solved

by reference to past learning. Some conclusions follow correctly from the premises while others do not. The subject indicates which conclusions are logically correct.

Time-limit: 8 minutes

Score: Number right.

### 39. Reasoning

Description: Constructed by Thurstone, the subjects are presented with formal, meaningful syllogisms, but some of the stated conclusions do not follow correctly from the premises. The subject indicates which inferences follow correctly from the premises.

Time-limit: 6 minutes

Score: Number right.

Factor V: Verbal Knowledge. This is one of the best identified factors involved in human ability. It has also been labeled Verbal Comprehension and Verbal Ability. It is defined as an ability embodying the knowledge and understanding of the English language. Since similar factors have been found in studies with native speakers of other languages, the Verbal Comprehension factor might be generalized in definition to be a factor of general language knowledge and comprehension. The following tests have been shown to have major loadings on this factor.

### 40. General Classification Test

Description: Part of the Navy Basic Test Battery, items in this test are of two types: (a) analogies, and (b) sentence completion. The Navy Basic Test Battery had been administered prior to this experiment and the test scores were made available by the Navy.

41. 36-Item Vocabulary

Description: Adapted from Carroll, this is a standard vocabulary test consisting of four-choice synonym items.

Time-limit: 10 minutes

Score: Number right.

42. Sentence Completion

Description: Constructed by Educational Testing Service, the subject selects the missing word of a sentence by deciding which word of five choices best fits the meaning of the sentence.

Time-limit: 7 minutes

Score: Number right.

Factor S: Spatial Relations and Orientation. Defined as the ability to comprehend the nature of the arrangement of elements within a visual stimulus pattern primarily with reference to the location of the subject. The following tests have been shown to have major loadings on this factor.

43. Cards

Description: Constructed by Thurstone, the subjects indicate which of six other cards in various rotational positions is "like" the stimulus card.

Time-limit: 6 minutes/20 items

Score: Number right.

44. Cubes

Description: Developed by Thurstone, the subjects indicate whether or not two drawings can be of the same cube, assuming no single cube can have two sides alike.



Time-limit: 5 minutes/44 items

Score: Number right.

Factor Vz: Visualization. Defined as the ability to perform mental manipulations of visual images. This ability is required in the solution of problems which involve a specified sequence of mental movements of objects appearing within a more or less complex stimulus pattern. The tests representing this factor are as follows:

45. Paper Folding

Description: Developed by Educational Testing Service, the subjects select from five choices the drawing which represents the unfolded version of the stimulus drawings. The stimulus drawings consist of two or three figures of a square piece of paper being folded and having a hole(s) punched in the last figure.

Time-limit: 10 minutes/20 items

Score: Number right.

46. Paper Form Board

Description: Developed by Thurstone, each item presents a drawing of black pieces which can be put together to form a figure presented in outline form. The subjects draw lines on the outline showing how the black pieces will fit together.

Time-limit: 7 minutes/42 items

Score: Number right.

Factor Mk: Mechanical Knowledge. Defined as knowledge of mechanical principles, devices, and tools, acquired through training and experience. The

following tests have been shown to have major loadings on this factor.

47. Mechanical Test

Description: Part of the Navy Basic Test Battery, items in this test consist of two types: (a) mechanical and electrical knowledge and (b) mechanical comprehension. Items of the latter type involve the ability to perceive visually the mechanical details of a problem situation and to apply various physical principles to arrive at a solution. The Navy Basic Test Battery had been administered prior to this experiment and the test scores were made available by the Navy.

48. Guilford-Zimmerman Mechanical Knowledge

Description: Part VII of the Guilford-Zimmerman Aptitude Survey, the subjects select one of five uses for a pictured tool or select one of five pictured tools for a given use.

Time-limit: 10 minutes/20 items

Score: Number right.

Factor N: Number Facility. This is also one of the better identified factors and is defined as facility in handling numbers in arithmetical operations. Tests of the four arithmetical operations are outstanding with respect to purity and loading on this factor. The following tests have been shown to have major loadings on this factor.

49. Addition

Description: This is a speeded test of the addition of sets of three, one-digit and two-digit numbers.

Time-limit: 3 minutes/90 items

Score: Number right.

#### 50. Division

Description: This is a speeded test of the division of two-digit or three-digit numbers by single-digit numbers.

Time-limit: 3 minutes/90 items

Score: Number right.

Factor Ai: Aiming. Defined as the ability to carry out quickly and precisely a series of movements requiring eye-hand coordination. It is distinguished from Motor Speed (Factor Ms) by its association with tests that require the exact placement of pencil marks rather than mere rapid markmaking. The following tests have been shown to have major loadings on this factor.

#### 51. Tracing

Description: Adapted from MacQuarrie, the subjects draw a line through a pattern requiring many turns.

Time-limit: 30 seconds for practice; 90 seconds for test

Score: Number of barriers passed.

#### 52. Dotting

Description: Adapted from MacQuarrie, the subjects put a dot entirely inside circles of  $1/16$  inch diameters which are connected by lines.

Time-limit: 30 seconds for practice; 90 seconds for test

Score: The number of circles with a dot within the circle.

Factor Ms; Motor Speed. Defined as the speed by which coordinated finger movements are carried out. Eye-hand coordination is minimal. Tests representing this factor are:

53. Writing X's

Description: The subject writes X's as fast as he can on or near dots.

Time-limit: 30 seconds for practice; 90 seconds for test

Score: Number of X's written.

54. Writing Digits

Description: The subject writes the digits 1 through 9 as fast as he can on or near blank lines.

Time-limit: 30 seconds for practice; 90 seconds for test

Score: Number of digits written.

55. Tapping

Description: U. S. Air Force Two-Plate Tapping Test in which the subject taps two plates alternately as rapidly as he can with a stylus held in the preferred hand.

Time-limit: Three 1-minute trials with 30-second rest periods between trials

Score: Cumulative number of recorded taps.

Factor MD: Manual Dexterity. Defined as the ability to conduct simple but speeded tasks requiring eye-arm-hand coordination. Factor PC: Psycho-motor Coordination, as represented in the Aiming Steadiness Test below, is subsumed here under Factor MD because it is a related factor and the test

representation of this factor is inadequate to define Factor PC distinctly.

Tests containing this factor include:

56. Turning

Description: From the Minnesota Rate of Manipulation Tests, this test utilizes a long narrow board which contains 60 holes in four rows of 15 each. The subject uses two hands in turning over each of the 60 cylinders and replacing them in the same hole.

Time-limit: Two 30-second test periods

Score: Total number of cylinders turned over.

57. Placing

Description: From the Minnesota Rate of Manipulation Tests, this test utilizes the apparatus of variable 56 (Turning Test). The subject puts the blocks in the holes as fast as he can using one hand only.

Time-limit: Two 30-second periods

Score: Total number of blocks placed in holes.

58. Steadiness

Description: U. S. Air Force Steadiness Aiming Test in which the subject attempts to hold a rod balanced on a fulcrum such that the end does not come into contact with the sides of a hole through which it is inserted.

Time-limit: Three 30-second trials; 30-second rest periods between trials

Score: Total amount of time rod is in contact with sides of hole.

Factor P: Perceptual Speed. Defined as the ability to compare pairs of items or to locate a unique item in a group of identical items. Tests of

this ability are always speeded. Tests containing this factor are:

59. Clerical Aptitude

Description: From the Navy Basic Test Battery, the subject indicates whether pairs of names or numbers are similar or different; the names or numbers in each pair differ only in some small detail. The Basic Battery was administered prior to this experiment and the test scores were made available by the Navy.

60. Picture Discrimination

Description: Items in this test consist of a set of three faces. The subject indicates which face is unlike the other two.

Time-limit: 3 minutes

Score: Number right.

Factor SA: Speed of Association. Defined as the ability to make rapid associations between objects and the words which symbolize them. Tests of this factor are:

61. Words Associated with an Unfurnished House

Description: The subject selects from a list of 497 words those which were associated with an unfurnished house.

Time-limit: 2 1/2 minutes

Score: Number right.

62. Word Checking

Description: The subject selects from a list of 250 words those which do not grow and which are smaller than a football.

Time-limit: 2 minutes

Score: Number right.

Intelligence. The popular lay definition that "intelligence is the ability to learn" led us to include three standard tests which yield a measure of intelligence. These tests are:

63. Armed Forces Qualification Test

64. Otis Self-Administering Achievement Test

65. Oral Directions Test

Two additional variables are included in the study. These are:

66. Education. Number of years of education completed beyond elementary level.

67. Age

## CHAPTER IV

### DATA COLLECTION AND ANALYSES

#### A. The Subjects

The experimental sample consisted initially of 483 enlisted men from eight recently formed companies. All subjects were undergoing recruit training at the U. S. Naval Training Center, Bainbridge, Maryland. The first tests of this project were administered during the first week of the regular nine-week training program; the last test was administered three weeks later. The total testing time per subject over the three-week period was 20 hours. When the data obtained from recalcitrant subjects and from subjects who were not present for one or more tests were excluded, complete and acceptable data were available for 315 subjects. The conclusions drawn in this report are therefore based upon 315 Naval recruits.

The subjects were 17 to 22 years of age with more than half of them falling in the 17-year-old group. In terms of education, they ranged from zero years of high school to two years of college; two-thirds of them had attended high school for three years or less. Intellectually, as reflected by scores on the Navy Basic Test Battery, the Armed Forces Qualification Test, and the Otis Mental Ability Test, the subjects were slightly below average and functioned at a level which would correspond to an average "I.Q." in the low 90's. A more complete description of the subjects may be obtained from the tables appearing in Appendix C.

#### B. The Testing Schedule

The subjects had been in the Navy only a few days during which time they had completed their basic processing and were assigned to one of



the eight companies. On June 1, 1955, the subjects attended en masse the "Welcome Aboard" ceremony conducted by Captain William J. Catlett, Commanding Officer of the Recruit Training Command at Bainbridge. At this time Captain Catlett described the learning project, asked for the subjects' cooperation, and introduced the writer. On June 2, 1955, five booklets of reference tests were administered to the men in four of the eight companies. The testing was conducted in an extremely large mess hall by Dr. John W. French and the writer. On June 3, 1955, subjects from the remaining four companies were given the reference tests. The order of presentation for these tests was constant for all subjects.

From June 7 to June 16 several additional reference tests and five of the 13 learning tasks were administered at the rate of one company per day. In order to test groups of subjects as small as four men and as large as 64 men, practical considerations required that the tests be administered in a "round-robin" manner to the subjects and, consequently, the order of presentation of these tests was not constant. These tests and those described in the next paragraph were administered by staff members of Educational Testing Service. The writer was solely responsible for administrative decisions and testing protocol.

The remainder of the learning tasks were administered to the subjects between June 17 and June 23. On each of these days, one or two tasks were given to all subjects. Some variation in the order of presentation existed when two tasks were administered--for example, in order to conserve on time two companies would participate in one learning task while two other companies participated in a second task and then the companies would exchange learning tasks.

The complete testing schedule showing the details briefly described above appears in Appendix D. Unknown consequences were introduced into the study by permitting the order of presentation for the reference tests and the learning tasks to vary for the subjects. A testing schedule in which the order of presentation was invariant for all subjects would have required an amount of time which would have seriously interfered with the operations of the training center. The adopted schedule which minimized interference with the training program was endorsed by the Chief of Naval Personnel, who also authorized that the normal nine-week training period be extended, if necessary, to make up instruction which may have been missed.

### C. Scoring and Collating Procedures

Scores on the tests in the Navy Basic Test Battery, which was administered during the recruits' processing period, and the Armed Forces Qualification Test, which had been administered prior to the subjects' entrance into military service, were obtained by permission from Naval records. The tests obtained in test booklets DETB1-5, as well as the Otis and Oral Directions Tests, were scored by the Scoring Section of Educational Testing Service. Performances on the Sidewalk Maze and the Turning and Placing Tests were scored by the subjects under close supervision from the persons administering those tasks. Performances on the Breech Block Performance Test, Meccano Assembly Test, Rotary Pursuit Test, Tapping Test, and Steadiness Test were rated by proctors or the persons administering those tasks.

The Word Code, Spatial Code, Knob Code, Sonar, Verbal Concept Formation I and II, Spatial Concept Formation I and II, and CIC Plotting Test were all scored by the subjects. These tasks represented nine of the 13 learning tasks involved in the study and the self-ratings were carefully scrutinized to insure accuracy. During the actual testing periods it was standard

procedure for the proctors to report to the test administrator the names of any subjects who for a variety of reasons were not actively participating or cooperating in the learning activity. After the answer sheets for a given task were collected, answer sheets for those individuals so reported were marked void. Answer sheets for these learning tasks, with the exception of the CIC Plotting Test, were later examined by the writer and other staff members of Educational Testing Service and rejected if the subject had failed to record his right and wrong responses or if for some other reason it was felt that the subject had not complied with the learning task. None of the answer sheets was rejected on the basis of learning. Inspection of the eight sets of answer sheets for 483 subjects produced 357 acceptable sets of data and 126 rejected sets of data (82 sets were rejected on the basis of being incomplete and included answer sheets marked void at the time of testing).

When the records for the 357 subjects who produced acceptable data on eight of the learning tasks were collated with data from the remaining learning tasks and reference variables, 42 subjects were lacking data on one or more of the variables and therefore excluded from the study. Complete and acceptable data for 315 subjects resulted from the scoring and collating procedures. No analysis--although it might be very important to do so--was made of the rejected data.

#### D. Computations of Learning Parameters and Correlation Coefficients

Scores for each trial and for each learning task were punched into IBM cards and the learning task parameters computed on the IBM 650 Electronic Data Processing Machine. The 28 learning parameters generated for the 13 learning tasks and scores for the reference data were punched into IBM





