This dissertation has been
microfilmed exactly as received

67-16,729

DREILING, Thomas C., 1930-

AN EXPERIMENTAL STUDY TOWARD THE DEVELOPMENT OF A NON-READING VERSION OF THE GENERAL APTITUDE TEST BATTERY.

The University of Oklahoma, Ph.D., 1967
Education, psychology

University Microfilms, Inc., Ann Arbor, Michigan

Downloaded from SHAREOK. Persistent Handle URL: https://hdl.handle.net/11244/2282

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

AN EXPERIMENTAL STUDY TOWARD THE DEVELOPMENT OF A NON-READING VERSION OF THE GENERAL APTITUDE TEST BATTERY

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

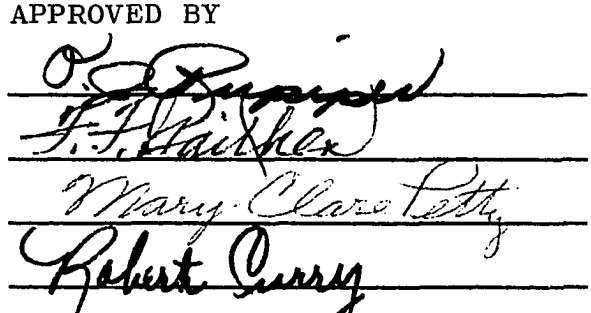
THOMAS C. DREILING

Norman, Oklahoma

1967

AN EXPERIMENTAL STUDY TOWARD THE DEVELOPMENT OF A NON-READING VERSION OF THE GENERAL APTITUDE TEST BATTERY

APPROVED BY



DISSERTATION COMMITTEE

ACKNOWLEDGMENTS

The writer expresses sincere appreciation to the members of his committee, Dr. O. J. Rupiper, Dr. Robert Curry, Dr. Mary Petty and Dr. F. F. Gaither, for their assistance in the completion of this study. Special appreciation is expressed to Dr. Rupiper for his invaluable advice, help and support throughout this study, and to Dr. Teska for his assistance throughout the writer's graduate program.

Special acknowledgment is given to Mr. Orbin Eckols and the United States Employment Service, Department of Labor, for their permission to use research test materials, currently in research use by that agency. Further acknowledgment is given to Warden Ray Page of the Oklahoma State Penitentiary for his permission to carry on this study at that institution and his cooperation in providing subjects.

Special expression of deepest gratitude is given to my wife, Sue, for her patient understanding and assistance, without which this study could not have been completed.

TABLE OF CONTENTS

Page

ACKNOWLEDGMENTS..... iii

LIST OF TABLES..... v

Chapter

I. INTRODUCTION..... 1

II. THE PROBLEM..... 13

Purpose..... 13
Sample..... 15
Method..... 16
Test Instruments..... 17
Hypotheses..... 20

III. PRESENTATION AND ANALYSIS OF THE DATA..... 21

IV. SUMMARY AND DISCUSSION..... 37

Summary..... 37
Discussion..... 39
Recommendations..... 44

REFERENCES..... 46

APPENDIXES..... 49

LIST OF TABLES

Table		Page
1.	t Values Between Groups by Variable.....	22
2.	Intercorrelation Matrix with Communality Estimates in Parenthesis.....	24
3.	Unrotated Factor Matrix.....	25
4.	Table of Residuals After Each Factor Extraction.....	26
5.	Rotated Factor Matrix.....	27

AN EXPERIMENTAL STUDY TOWARD THE DEVELOPMENT OF A NON-READING VERSION OF THE GENERAL APTITUDE TEST BATTERY

CHAPTER I

INTRODUCTION

The science of measurement traces its infancy to the application of the "personal equation" by a German astronomer in 1816. The "personal equation" of that astronomer was a comparison of observations made by a number of individuals on an objective task and has become today known as "individual differences."

The first psychological laboratory in 1879 incorporated to some degree the earlier methods of comparison when dealing with human behavior. Stevens (1951) contends that much of the measurement today should be a preoccupation with psychophysics in its older and broader meaning, which is discovered primarily by finding rules that relate to organisms and their environment.

In the 1700's, new concepts of measurement had been developed which were to affect psychophysical observations. The Gaussian or "normal curve" came into existance. Quetelet

is credited with being the first to apply the theory of the "normal curve" to biological and social data. About the same time that Quetelet's observations were made, Englishman Charles Darwin publicized his revolutionary ideas concerning inheritance and biological evolution. Francis Galton became quite interested in the work of Quetelet and Darwin and attempted to treat the idea of inheritance and genius by measurement and mathematical theorems. Concerning Galton, Horrocks mentions:

> It is to Galton that present day psychology is indebted for scaling methods and for such concepts as regression, correlation, and standard scores. Much of modern statistics can reasonably be dated from his work. In addition, his contributions to the use of measurement were considerable (1964, p. 11).

Karl Pearson and Charles Spearman were Galton's assistants at his anthropometric laboratory, which he established in 1882, and they continued to carry on Galton's work after his death. Both were firmly convinced that the application of statistical procedures was the only method which should be employed in the area of psychophysical measurement.

In Germany, Ebbinghaus became involved in the study of memory, and he applied statistical methods to data he collected during the same period of time as did Pearson and Spearman. In France, Binet developed studies in individual differences which led to the first Simon-Binet Intelligence test. E. L. Thorndike in the United States was busy applying

statistical analysis to a number of tests which purportedly measured achievements and aptitudes. In 1910, Whipple published two volumes that included tests for the measurement of physical and motor abilities and described tests of association, learning and memory. These publications were the first that discussed psychomotor tasks as such, and were considered separate from other "higher" mental processes.

In 1898 the toddling new science of psychology had incorporated the application of statistical methods to measurement and continues today to lean heavily on statistical analysis. A resume of the task of measurement to all of the psychological dimensions of human behavior is enoumous and superfluous to the aims of this study, as it is primarily concerned more with a specific area of measurement, that of vocational or occupational assessment.

The first consideration of special abilities relevant to an individual's performance on a specified task occurred in the field of industrial psychology shortly before World War I. Munsterburg (1913) was the first to point out the role of the psychologist in assessing the aptitudes and abilities necessary for a man to do a particular job. According to Horrocks:

> In the United States tests for telephone operators by McComas, for telegraphers by Jones, Scott's study of the interview in the selection of salesman, and a study by Rogers of tests for typists and stenographers were the precursors of aptitude testing designed for industry (1964, p. 322).

The United States Army felt a need to measure the intelligence and aptitudes of the young men entering the Armed Forces and, as a result, the Army General Classification Test was developed. In addition, a number of performance tests were administered to give an indication of the general intelligence level along with scores on separate abilities and aptitudes. Other aptitude type batteries were developed which have led to such modern day tests as the Differential Aptitude Tests of the Psychological Corporation and the General Aptitude Test Battery of the United States Employment Service.

The Differential Aptitude Test attempts to measure specific aptitudes relevant to the battery as a whole, while the General Aptitude Test Battery, (hereafter referred to more simply as the GATB) does not utilize all the tests in its battery as a predictor of aptitudes for one specific occupation.

The GATB has been chosen for subject matter in this study because of two factors: It is the most widely used vocational battery today; the statistical soundness upon which it is developed suggests that it is a sophisticated and highly reliable instrument for predicting vocational fitness for hundreds of contemporary job requirements. Super and Crites state:

> Despite the fact that some of the normative groups are still small, and some of the validity coefficients therefore too large

> and despite the use of concurrent as well as predictive validation criteria, there is no doubt but that this is the most adequately standardized and validated battery of tests now available for the vocational counseling and placement of inexperienced young persons and adults. The large and varied number of partly validated occupational aptitude patterns are equalled by no other battery (1962, p. 338).

It is generally concluded that the first notions of constructing a test battery similar to the GATB came out of the Research Institute of the University of Minnesota as reported by Patterson and Darley in 1936 and by Dvorak as early as 1935.

The first edition of the GATB was published in 1947 and was known as the GATB, B-1001 (Dvorak, 1947, p. 42-43). Shartle, Dvorak, Heinz and others (1944) reported on ten years of research that had laid the groundwork for the development of the GATB. During this period of time, 100 or more separate aptitude tests had been developed along with specific apparatus tests. This great number of individual tests was then factor analyzed according to Thurstone's method of multiple factor analysis. His technique utilizes the centroid method of extracting factors from the correlational matrices and, by a process of rotation, maximizes the number of zero leadings on each factor that is extracted.

Factor analysis was a relatively new mathematical technique for the treatment of psychological data in the 1930's and 1940's. It is significant that the analysis of data for the first GATB version was factor analyzed. In

writing about the confusion concerning the use of statistics when applied to the behavioral sciences, Horst mentioned:

> ...the increasing confusion of tongues must be halted if psychology is to become a respectable science. Fortunately within the last four decades a methodology has been emerging which gives considerable promise of bringing order out of this chaos. This methodology has come to be known as factor analysis (1966, p. 143).

Vernon (1950) placed the GATB investigations based on factor analysis as one of the landmarks in the development of that technique. As a methodology for treatment of data, it appeared to be one of exactness since the massive number of correlations necessary to extract the factors was done mechanically.

The general objective in the development of the GATB was to measure the factors that have been found to underlie the most valid aptitude tests and to develop occupational norms and validity data for these factors. This would make it possible to test virtually all significant aptitudes in one testing session. In addition, it allowed one to interpret a person's scores in terms of a wide range of occupations. According to Dvorak:

> The basic assumption underlying the GATB is that a large variety of tests can be boiled down to several factors and that large varieties of occupations can also be clustered into groups according to similarities in the abilities required. This makes it feasible to test all of a person's vocational abilities in one sitting and to interpret his scores in terms of a wide range of occupations (1956a, 1. 145).

The original factor analysis for the first version of the GATB included 59 separate tests, some of which were used by the United States Employment Service to determine those aptitudes believed necessary in certain occupations. From these 59 tests, first 15 and then 12 factors were extracted which measured what appeared to be 10 separate aptitudes. Subsequent analysis reduced the factors to 9, the form of GATB, B-1002, which is currently used today.

The first edition of the GATB B-1001 comprised 11 paper and pencil type tests and 4 apparatus type tests. Section II of the GATB manual outlines the procedures of the development of the GATB B-1002:

> The construction of items for the separate answer form of the GATB B-1002, involved two major phases: (1) the revision of test items that had been included in the original edition of the GATB B-1001, to adapt them for use with a separate answer sheet; and (2) the construction of new test items....The primary task in the revision of the B-1001 items to adapt them for a separate answer sheet was conversion to the multiple-choice type of all items that were already not in this form (1962, p. 1).

The GATB B-1001 population sample comprised five groups with a total sample of 519 workers. Their average age was 30.39 years and their average educational level was 10.97 years. Three studies followed that included a General Working Population of 4,000 individuals, one hundred High School seniors, and 2,649 Airmen, which resulted in the present standardization group.

The GATB norms are expressed in terms of occupational aptitude patterns which consist of critical cutting scores for three of the primary aptitudes considered necessary in one particular job. Section II of the GATB manual (1964) lists 36 of these occupational aptitude patterns, commonly referred to as OAP's. The first step in developing an OAP, according to Dvorak (1956), is a job analysis. By observation of the job and interviewing workers in that job, certain skills, abilities, training, etc., are recorded which are deemed important aspects of the task involved. The next step is selection of good criteria or a measure of job efficiency. Lastly, the GATB is administered to a homogeneous sample of workers in that job. OAP categories follow the Dictionary of Occupational Titles format.

Form B of the GATB, B-1002 was utilized in this study. Super and Crites list the nine factors and the tests used to tap these factors:

G- Intelligence: general learning ability, ability to grasp instructions and underlying principles. It is often referred to as scholastic aptitude and is measured by three tests, which are Verbal ability, Spatial ability and Numerical ability.

V- Verbal Aptitude: ability to understand the meaning of words and paragraphs, to grasp concepts presented in verbal form and to present ideas clearly. This is measured in one test.

N- Numerical Aptitude: ability to perform arithmetic operations quickly and accurately. This aptitude is measured by two tests, fundamentals of arithmetic and arithmetic reasoning.

S- Spatial Aptitude: ability to visualize objects in space and to understand the relationships between solid and plane forms or objects. Measured in one test.

P- Form Perception: ability to perceive pertinent detail in objects or in graphic material, to make visual comparisons and discriminations in shapes and objects. This is measured by two tests, shaded tools or common objects, and matching symbols.

Q- Clerical Perception: ability to perceive pertinent detail in verbal or numerical material, to observe difference in copy, tables, lists, etc. It is measured by one test.

K- Motor Coordination: ability to coordinate hand movements with visual judgments, speed and precision. This is measured by one test which requires mark making.

F- Finger Dexterity: ability to move fingers and manipulate small objects rapidly and accurately. This aptitude is measured by two tasks similar to those required in the Purdue Pegboard.

M- Manual Dexterity: ability to move the hands easily and skillfully, a grosser type of movement than finger dexterity which incorporates movement of fingers, arms and upper trunk (1962, p. 332).

Most of the primary aptitudes deemed necessary for occupational categories were present. Not included are very specific aptitudes or abilities, such as Art judgment and musical ability. For the most part, however, the above tests for aptitude measurements cover the vast majority of occupational aptitudes that have been discovered to date.

The application and use of the GATB is widespread. Dvorak (1956b) lists 83 individuals and organizations in 28 foreign countries who make use of the test. A Spanish version of the GATB is available in this country for Spanish-speaking citizens.

In recent years, experimental studies with the GATB have been numerous. Dvorak (1956a) lists a number of unpublished theses and dissertations in a selected bibliography. The majority of these deal with use of the GATB in academic settings where the test has been used for its predictive validity. Odell (1949) used it in the area of selective placement. Samuelson (1956) utilized the GATB in predicting success of vocational school students. He found the predictive value of the test to be significant with a rating criterion by teachers.

Sharp and Pickett (1959) found that the GATB could be used as predictor of college success in their study at Utah State University. Cumulative grade point averages were compared with individual GATB scores and correlations as high as .46 were found. Storrs (1952) found that Factors, G, V, and N of the GATB correlated highly with the Verbal subtests of the Wechsler Bellevue I and that Factors S, P, and Q correlated highly with the W-B Performance subtest.

In establishing GATB norms for students in lower high school grades, Droege (1960) found a close relationship between GATB scores and prediction of occupational and college success.

Hirt (1959) conducted a study concerning age and aptitude as measured on the GATB. He found that only factor K (motor coordination) showed variance when age was considered as a criterion. He concluded that there is a curvilinear relationship between age and factors G, V, N, and S.

In his comments on Dvorak's report, Super concludes:

> As test users, we must keep our perspectives. The data now available leave much to be desired. At the same time, the data now available represent the most extensive and careful program of occupational test development ever carried out for civilian occupations. They are impressive in their scope and substantial in their validity. The reporting of what has been done is becoming more complete and more detailed, as manuals are revised and as more articles appear in professional and scientific journals. We can only hope that this program will be so well supported in the future that Dr. Dvorak and her colleagues may be enabled to pursue a more active program of data collection, analysis, and publication. In the meantime, we have here a useful tool (1956, p. 154).

Research studies on the GATB have been numerous since 1956 and an intensive program is now in progress. Dvorak (1965b) reviews the research program from the inception of the first GATB version in 1947. She points out that originally GATB occupational norms were available only for adults. Sometime later, norms were developed for 9th and 10th graders, and in 1958 a follow up study was made for verification of these norms along with a maturational study. More recent studies have been concerned with educationally deficient individuals and with trainees in the MDTA.

Dvorak, Droege and Seiler reported on research that had shown the validity of using a screening device for individuals who could take the GATB with the conclusion:

> Analysis of the data indicated that effective screening could be developed through use of a device consisting of practice items on the vocabulary and three-dimensional space tests of the GATB (1965, p. 138).

In the same report, the authors note the present research program now in progress on the development of a non-reading edition of GATB and the work that has lead to a non-reading version of Aptitude G. This substitute test is a weighted composite of the Figure Series, Figure Classification and Matrices subtests of the Culture Fair Test and the Form Matching Test of the GATB. According to the authors, the non-reading measure of Aptitude G will serve as an interim measure until something more refined has been developed.

The brief history of vocational testing has been a progression to the use of multiple tests to measure specific aptitude and abilities. The preferred method of administration consists of a battery of tests that may be given at one sitting. Because the GATB offers this convenience along with OAP categories, it has become the most widely used test of its kind. Continuing research enhances the suggestion that it will continue to be a popular and useful vocational tool.

CHAPTER II

THE PROBLEM

Purpose

Beginning in 1963, the GATB has been administered routinely to every new inmate at the Oklahoma State Penitentiary who could read and write. The test results were utilized by the classification committee for job selection and by the Oklahoma Division of Vocational Rehabilitation for vocational counseling. The test results became a part of the inmate's permanent record and were transferred whenever the inmate was sent to the State Reformatory or to one of the Penitentiary satellite honor stations.

A 1964 Penitentiary report noted that the average formal grade completed by incoming inmates was the 8th grade. For those who had not achieved this level, many of them were handicapped by their slow rate of reading and writing. The illiterates were given the Revised Beta to afford some indication of their I.Q. level. For both groups, the illiterates and slow readers, test results were somewhat dubious and unreliable. Through a screening process, the illiterates' names were eliminated before GATB testing. It seemed quite

obvious that a majority of the slow readers could not compete with the average reader and consequently were penalized by their handicaps on each timed test in which reading was required.

In view of the handicap of many of the incarcerated inmates, the obvious problem was to afford some means of assessing the aptitudes of the slow readers and illiterates who could not perform adequately on reading or writing tests. In order to utilize non-reading tests, it seemed desirable that such tests should parallel as closely as possible those subtests in the GATB that required reading ability.

The problem of this study was to combine a group of relatively simple non-reading tests that measured general and specific aptitudes which would be appropriate and adequate for assessing these measures for incarcerated inmates and for the administration and exploration of their factor structure.

The purpose of this study was to make preliminary exploration of the factor structure of these tests as a first step in the development of specifications for the tests in terms of factor structure and possibly leading to the reporting of factor scores useful in improving prediction of the slow reader and illiterate. The study was frankly exploratory and was designed to assist in generating hypotheses which might be tested in later studies.

The second purpose in studying the factor structure was to evaluate the structure of three non-reading tests in research by the USES at the present time. A survey of the literature did not reveal that these tests had previously been administered to inmates in a correctional institution. Factor analysis of these tests being administered to incarcerated inmates constituted a new facet in research of these tests.

THE DESIGN

Sample

A sample of 150 male inmates confined in the Oklahoma State Penitentiary during the month of February, 1967 were utilized for this study. Random selection was made by choosing every fourth inmate who had last been administered the GATB. Before the random sampling, inmates had been placed in three age groups: Group I, which included those who were in the 16 through 25 year age, Group II which included those inmates who were from 26 through 35 years of age, and Group III which included those in the age range of 36 through 60 years of age. Appendix A lists the age distribution of subjects in the sample by groups along with the means and standard deviations. For Group I, the mean age was 20.28 years with a standard deviation of 2.29 years; Group II, the mean age was 29.88 and the standard deviation 2.81 years; and Group III, the mean age was 42.70 and standard

deviation of 5.11 years of age. The higher standard deviation in Group III was perhaps a function of the wider distribution of subject's age in this group. These age groups were selected because they best represented the normal age distribution in the institution and would afford better statistical comparison.

Method

All inmates in this study had previously been administered the GATB by a representative of the Oklahoma State Employment Division. Each subject had taken the GATB within 90 days prior to administration of the tests utilized in this study.

Five inmates were administered the tests prior to collecting data for this study in order to determine time required for testing and familiarizing the author and two inmate assistants with administrative procedures and instructions. These data were not used in this study.

The selected subjects for the study were administered the tests in six groups of 25 inmates per group. Each group comprised subjects whose age was appropriate to their age group. After being seated in a well lighted room appropriate for testing, the following instructions were read to them:

> "You have been asked to participate in an experiment in which you will take a number of tests to help us determine whether we can assess the value of some tests for individuals

> who cannot read or write. Since you have agreed to take the tests, I feel that you will be motivated to do your best on them. If you have any questions, please ask them now or during the instructions prior to each test. If you do not understand the instructions, hold up your hand and myself or one of the assistants will help you."

The tests were then administered in the following order, Ammons Picture Vocabulary Test, Part 6 of the Revised Beta, The Matrices Test, Coin Matching Test, and the Coin Series Test. The subjects were then taken individually into a smaller room and administered the Arithmetic subtest of the Wechsler Adult Intelligence Scale. This completed the test administration for each individual subject who was then sent away from the testing area in order to avoid any coaching of inmates who had not taken the Arithmetic test.

Test Instruments

The Ammons Full Range Picture Vocabulary test was selected for use in this study because it appears to be one of the more reliable Vocabulary type tests in use today. The present author has used it frequently in making comparison with I.Q.'s obtained from the California Test of Mental Maturity or the Revised Beta and has observed what appears to be a rather close correlation in range to the above mentioned tests. A modification was made in the administration of this test in which each of the four pictures on a plate was identified by a meaningless symbol such as Z,

O, I, and X. The subject was told to blacken out the correct symbol on his answer sheet. Other than this addition, the instructions were administered as prescribed.

Part 6 of the Revised Beta was chosen for use in this study because of the lack of cultural and linguistic influence in a same-opposites type of test. The first two test items were used for demonstration purposes and each subject was checked individually in order to assure that he followed and understood the instructions.

The Arithmetic subtest of the Wechsler Adult Intelligence Scale was administered according to the instructions in the Manual. It was chosen to be used because of its reliability in tapping factors closely related to ability to deal with numerical concepts which assumed some basic arithmetic skills.

The USES Matrices Test is a research test which contains 29 matrix items which are in order of increasing difficulty for low education individuals. The test was used in order to evaluate its factor loading in regard to other tests used in this study.

The USES Coin Matching Test is another research test which contains sixty items. The examinee must indicate whether two groups of coins have the same value. This test was used in this study to evaluate the derived factor loadings in relation to numerical ability and basic arithmetic skills.

The USES Coin Series Test is a research test composed of three parts. Part I contains 72 items in which the examinee must mentally manipulate groups of coins according to an assigned system. Part II and III each contain 46 items of the same type as Part I. The purpose of using this test in this study was to evaluate the factor loadings in relation to factors such as ability to deal with numerical concepts.

Each of the three USES Research tests were administered as prescribed by the directions for each individual test.

The following test or sub-tests were administered in this study which resulted in the study of 15 variables. The number preceding each test was for purposes of identification and was followed by the abbreviation used for that respective variable.

1. G, General Learning Ability.
2. V, Verbal Aptitude.
3. N, Numerical Aptitude.
4. S, Spatial Aptitude.
5. P, Form Perception.
6. Q, Clerical Perception.
7. K, Motor Coordination.
8. F, Finger Dexterity.
9. M, Manual Dexterity.
10. AR, Ammons Full Range Picture Vocabulary Test.
11. RB, Part 6, The Revised Beta Test.
12. WA, Arithmetic sub-test, Wechsler Adult Intelligence Scale.

13. MA, Matrices Test.
14. CM, Coin Matching Test.
15. CS, Coin Series Test.

Hypotheses

In order to illustrate experimentally the feasibility of utilizing non-reading tests as substitutions for reading tests in the present form of the GATB, B-1002, the following specific hypotheses were formulated:

1. The Ammons Full Range Picture Vocabulary Test scores will show high factor loadings on the same factor that is assumed to measure Factor G, Learning Ability on the GATB.

2. The Ammons Full Range Picture Vocabulary Test scores will show high factor loadings on the same factor as Factor V, Verbal, on the GATB.

3. The Arithmetic subtest of the Wechsler Adult Intelligence Scale results will show high factor loadings on the same factor that is assumed to measure Factor N, Numerical, on the GATB.

4. Test Part 6 of the Revised Beta Test results will show high factor loading on the same factor that is assumed to measure Factor Q, Clerical, on the GATB.

The use of the USES non-reading research tests will be of an exploratory nature and will be utilized to determine factor structure relevant to this study.

CHAPTER III

PRESENTATION AND ANALYSIS OF THE DATA

The GATB scores for each individual were transformed to converted scores since various combinations of subtest scores were used to determine a single aptitude score. Raw scores were used for the remaining tests. The obtained test scores for each subject are presented in Appendix B by age, identification numbers and test variables.

The mean scores for each of the fifteen test variables were studied for possible age group differences. The results, which are presented in Table 1, show that statistically significant age group differences were observed in scores for the S, P, K, RB, and CS test variables in favor of the older age group when Groups II and III were compared (Guilford, 1956). When the older age group was compared with the younger age group, the group differences were significantly larger for the S, P, F, M, RB, MA, and CS test variables. Only on one test variable, AR, the significant difference was in favor of the younger age group. Similar scores were obtained on all other test variables by the three age groups.

TABLE 1

t VALUES BETWEEN GROUPS BY VARIABLE[a]

Variable	Group I vs. II	Group I vs. III	Group II vs. III
G	-.72	1.57	2.14
V	-1.10	.49	1.46
N	-1.23	1.06	2.18
S	.46	3.33**	2.87**
P	2.60	5.89**	4.03**
Q	.23	1.82	1.57
K	-2.15	1.56	3.24**
F	1.97	3.10**	.70
M	.01	2.75**	2.50
AR	-1.74	-2.72**	-.70
RB	-.06	3.19**	3.24**
WA	-.52	.00	.53
MA	2.01	3.74**	1.59
CM	-.39	2.33	2.49
CS	1.69	4.82**	2.89**

[a]Negative sign indicates direction of difference e.g., $\overline{X}$ difference between Group I vs. II on test variable G is in favor of Group I.

**Denotes value is significant of .01 level.

These findings suggest that the subjects between ages 36 and 60 perform better on spatial relations, form perception, motor coordination, coin series, and Revised Beta tests than do subjects between the ages of 16 and 35. However, the younger subjects, ages 16-25, perform better on arithmetic tests. Although the average scores by age groups were essentially the same for most test variables, a difference seemed to emerge in favor of the older group.

Since only 13 significant differences were obtained from 45 comparisons by age groups, it seemed reasonable to combine age groups for analyzing the test results by factor analysis. This combination would increase the size of sample and give greater stability to the isolated factors.

Intercorrelations obtained among the 15 test variables are presented in Table 2. The parenthetical correlations in the diagonal represent the communality estimates. The resulting matrix was factor analyzed by the method of verimax rotation at Computer Services Company, Del City, Oklahoma on the IBM 7040 computer system using a Fortran program. Table 3 presents the obtained unrotated factor matrix. An examination of the distribution of residuals after each factor extraction, Table 4, led to the retention of eight factors, which together accounted for 100.14% of the total variance. The rotated factor loadings, together with the percentage of variance accounted for by each factor, are presented in Table 5. One relatively large factor emerged,

TABLE 2

INTERCORRELATION MATRIX WITH COMMUNALITY
ESTIMATES IN PARENTHESIS
(n = 150)

VARIABLES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	(.88)	.79	.88	.72	.52	.69	.38	.33	.36	.63	.53	.64	.67	.54	.60
2		(.79)	.66	.47	.38	.63	.33	.21	.28	.63	.45	.51	.58	.46	.56
3			(.88)	.57	.46	.70	.32	.26	.30	.56	.49	.64	.59	.50	.54
4				(.72)	.61	.51	.29	.39	.40	.42	.39	.35	.55	.41	.52
5					(.61)	.55	.41	.43	.46	.30	.48	.36	.49	.49	.54
6						(.70)	.40	.36	.37	.52	.60	.44	.55	.52	.57
7							(.50)	.36	.50	.29	.35	.14	.35	.31	.28
8								(.59)	.59	.26	.30	.18	.37	.33	.31
9									(.59)	.26	.36	.19	.36	.36	.39
10										(.63)	.29	.50	.48	.37	.31
11											(.60)	.47	.51	.56	.53
12												(.64)	.59	.50	.44
13													(.67)	.56	.64
14														(.56)	.48
15															(.64)

TABLE 3

Unrotated Factor Matrix
(n = 150)

	FACTOR							
Variable	I	II	III	IV	V	VI	VII	VIII
1	.91	-.24	.16	.14	-.02	.06	-.09	.07
2	.76	-.28	.17	-.09	-.16	-.25	-.02	-.02
3	.83	-.30	.09	.05	-.04	.29	-.17	-.05
4	.72	.11	.08	.48	.06	-.00	.10	.05
5	.67	.30	-.13	.18	-.04	.05	.14	.07
6	.79	-.02	-.00	-.07	-.27	-.09	.12	-.16
7	.49	.26	.19	-.21	-.17	.03	-.04	.24
8	.48	.51	.13	-.04	.21	.02	-.00	-.19
9	.53	.55	.15	-.10	.08	.00	-.15	-.02
10	.64	-.24	.37	-.15	.13	-.09	.18	-.03
11	.67	.07	-.32	-.17	-.13	.08	.07	-.00
12	.66	-.34	-.18	-.15	.32	.08	-.02	.15
13	.77	-.03	-.14	-.01	-.15	-.17	-.04	.07
14	.67	.04	-.23	-.15	.08	.03	.10	.03
15	.72	.05	-.27	.11	-.10	-.23	-.17	.08
Contribution of factor	7.30	1.21	.58	.46	.36	.27	.18	.15
%	69.81	11.58	5.52	4.42	3.43	2.53	1.76	1.43
Sum %	69.81	81.39	86.90	91.33	94.75	97.29	99.04	100.48

TABLE 4

TABLE OF RESIDUALS AFTER EACH FACTOR EXTRACTION

Residuals After Extraction	Factor I	II	III	IV	V	VI	VII	VIII
.20 and over	219	11	1	1	0	0	0	0
.15 to .20	4	4	3	0	0	0	0	0
.10 to .15	2	12	7	4	1	1	0	0
.05 to .10	0	24	24	16	9	4	0	0
.00 to .05	0	60	84	114	125	140	161	175
-.05 to .00	0	58	78	68	78	78	64	50
-.10 to-.05	0	28	24	20	12	2	0	0
-.15 to-.10	0	24	4	2	0	0	0	0
-.20 to-.15	0	4	0	0	0	0	0	0
-.20 or less	0	0	0	0	0	0	0	0

TABLE 5

Rotated Factor Matrix
(n = 150)

		FACTOR							
		I	II	III	IV	V	VI	VII	VIII
G	1	.61	.15	-.25	.42	.29	.40	-.20	.14
V	2	.72	.07	-.26	.15	.16	.13	-.34	.16
N	3	.50	.10	-.30	.27	.33	.59	-.12	.07
S	4	.28	.28	-.16	.74	.15	.13	-.16	.06
P	5	.13	.37	-.46	.46	.10	.07	-.09	.11
Q	6	.46	.22	-.55	.22	.09	.23	-.16	.15
K	7	.18	.42	-.20	.09	.02	.05	-.05	.54
F	8	.10	.72	-.13	.17	.10	.00	-.04	.02
M	9	.10	.73	-.17	.12	.03	.09	-.11	.20
AR	10	.75	.18	-.10	.13	.23	.04	.04	.05
RB	11	.17	.20	-.65	.11	.25	.12	-.16	.12
WA	12	.37	.04	-.25	.11	.69	.16	-.11	-.00
MA	13	.38	.26	-.35	.26	.39	.05	-.30	.03
CM	14	.22	.24	-.47	.17	.41	.02	-.12	.11
CS	15	.20	.22	-.39	.29	.22	.10	-.56	.06
Contribution of Factor		2.48	1.76	1.84	1.34	1.22	.67	.70	.45
% Common Variance		23.65	16.86	17.56	12.86	11.69	6.43	6.74	4.34
Cumulative %		23.65	40.52	58.08	70.94	82.63	89.06	95.80	100.14

accounting for 23.65 percent of the common variance. The next four factors were moderately large and accounted for 16.86, 17.56, 12.86, and 11.69 percent of the common variance, respectively. The other three factors were very small in magnitude, together accounting for only about 17 percent of common variance. For this study, a factor loading of .30 or greater was chosen as significant for that factor.

FACTOR I

The variables having the highest loading in this factor were:

Ammons	.75
V, Verbal	.72
G, Learning Ability	.61
N, Numerical	.50
Q, Clerical	.46
Matrices	.38
Wechsler Arithmetic	.37

Scores on Ammons Full Range Picture Vocabulary Test yielded the highest factor loading with Verbal and G (Learning Ability) the next highest. It seemed important to realize that Verbal was one of the three composite scores that comprised G in the GATB. The high loading of Verbal may be due to an added contribution on this particular factor. From this finding it could probably be inferred that Verbal was an important ingredient in the composition of learning ability. The relative high loading of Numerical seemed plausible since arithmetic reasoning comprised approximately one half of the Numerical Score on the GATB and was one-third

of the contribution to G, the Learning Ability score. Q (Clerical) denoted an ability to perceive pertinent detail in verbal or tabular form. This may be the possible explanation that Part 6 of the Revised Beta did not show a significant factor loading on this factor, namely, that the present Q in the GATB may be a source of picking up a verbal factor that was not present in Part 6 of the Revised Beta.

The .37 loading of the Wechsler Arithmetic subtest seemed plausible in view of the fact that some fundamental knowledge in arithmetic was required before arithmetical reasoning could take place. Arithmetic Reasoning comprised one-third of the contribution to the G score. The .38 loading of the Matrices Test was in agreement with earlier research (Dvorak, Droege, and Seiler, 1965) in which the authors noted that several of the items constructed to tap numerical ability may contribute to the measurement of G, (Learning Aptitude).

FACTOR II

The variables having the highest factor loadings on this factor were:

M, Manual Dexterity	.73
F, Finger Dexterity	.72
K, Motor Coordination	.42
P, Form Perception	.37

This study was not primarily concerned with the non-reading performance type tests used in the present form of

the GATB. The above factor loadings required little inspection to determine the quality of the factor that was extracted. Undoubtedly, the three highest loadings represented performance tasks of speed and agility while the fourth was a visual and perceptual type matching requirement. This factor may well represent that which was extracted during the earlier development of the GATB and added evidence to the validity of those studies.

FACTOR III

The variables having the highest factor loadings on this factor were:

RB, Revised Beta	.65
Q, Clerical	.55
CM, Coin Matching	.47
P, Form Perception	.46
MA, Matrices	.35
N, Numerical	.30

As indicated by the loadings, RB and Q had high loadings. Inspection of the tasks involved in both tests suggested an ability of perceptual detail, especially for likes and opposites. Since the tasks were obtained from subjects who were able to read, it appeared plausible that the lack of readable items on the RB would strengthen the contention that it was a more selective test for this aptitude than one that contained items which were relevant to reading ability.

While the Coin Marching Test did contain some numerical reasoning aptitudes, primarily it was a matching

type test wherein the coins themselves must be matched. This could only be accomplished by knowing what each coin represented.

Form perception was composed of both tool and form matching and was primarily a likes-opposite test. Its loading on this factor was consistent with the type of task required.

While Matrices and Numerical have relatively low loadings, it was not quite clear why they should load on this factor. However, with one exception, the Matrices test involved matching type items.

FACTOR IV

The variables having the highest loadings on this factor were:

S, Spatial	.74
P, Form Perception	.46
G, Learning Ability	.42

In considering the task requirements, this factor represented an aptitude for spatial abilities. The extraction of this Factor enhances the validity of previous studies on the GATB. Form Perception had been considered primarily a likes-opposites task. Its loading on this factor suggested the necessity of spatial ability when dealing with transformation of similar forms. The loading of G on this factor was not understood since spatial abilities did not contribute to G in the present form of the GATB.

FACTOR V

The variables having the highest loadings on this factor were:

WA, Wechsler Arithmetic	.69
CM, Coin Matching	.41
MA, Matrices	.39
N, Numerical	.33

The highest loading on this factor was the Wechsler Arithmetic Sub-test. In evaluating the content of this subtest, it was evident that an aptitude for arithmetical reasoning had been extracted. It seemed obvious that there was some distinction between an ability to recall basic arithmetic fundamentals and a more automatic ability to incorporate the learned principles of arithmetic in verbally presented problems.

Coin Matching seemed to imply an ability for distinguishing differences only after having learned assigned values. The loading here may be due to the ability of having learned the values before the necessity of making comparisons.

Matrices Test loading on this factor connotated an aptitude of manipulating numerals and symbols conceptually. This seemed to yield consistent results with the tasks required on the Wechsler Arithmetic sub-test.

The Numerical loading appeared consistent with the type of task required on Part 6 of the GATB, which was a composite of Numerical Aptitude.

FACTOR VI

The variables having the highest loadings on this factor were:

N, Numerical	.59
G, Learning Ability	.40

The two factor loadings on Factor VI were difficult to evaluate. The N loading of .59 suggested a combination of aptitudes for Arithmetic Reasoning and Computation (the two composites that make up the N factor on the GATB). Arithmetic reasoning was a weighted portion of G, Learning Ability. It seemed apparent that this factor pointed to a communality that was not consistent with the Arithmetic Reasoning as evaluated on Factor V. There was the possibility of a guess-type error in Part 6 of the GATB, where the task was quite similar to the Wechsler Arithmetic tasks. The examinee had four multiple choices on Part 6, while he had only one correct answer on the Wechsler Arithmetic. The loading of G on this factor seemed plausible in view of the fact that N was a composite of G, Learning Ability.

FACTOR VII

The variables having the highest loadings on this factor were:

CS,	Coin Series	.56
V,	Verbal	.34
MA,	Matrices	.30

This factor extraction apparently dealt more with an ability or aptitude for understanding verbal instructions

than an ability or aptitude for dealing with numerical concepts. The distribution of Coin Series raw scores yielded a bi-modal curve. The author experienced difficulty with the instructions when administering the Coin Series test which was discussed in Chapter IV. It seemed plausible that a verbal factor was evident in each of the three variables that showed a loading on this factor and that an ability to comprehend verbal instructions in order to find a solution to the task was necessary in two tests, CS and MA. The exact explanation of what was being measured on this factor is not understood at this time.

FACTOR VIII

The variable having the highest loading on this factor was:

K, Motor Coordination .54

The solitary significant loading on this factor was self-explanatory. Part 8 of the GATB was a mark making task that called for eye-hand-finger motor coordination and it was a timed test. Factors F and M in the GATB did not show a significant loading which suggested that mark making was a specific psychomotor aptitude.

It was consistent with earlier GATB studies that all of the nine factors which comprise the GATB showed factor loadings. Factors II, IV and VIII extracted in this study require psychomotor tasks and are defined as such in the present GATB, B-1002.

Following is a brief resume of the eight factors extracted and a definition of the aptitude measured by each factor:

Factor I. General learning and Numerical ability.
Factor II. Gross manual dexterity.
Factor III. Likes-opposites type of task, utilized in measuring Clerical aptitude.
Factor IV. Aptitude for Spatial ability.
Factor V. Aptitude for Arithmetic reasoning.
Factor VI. Aptitude for Numerical ability.
Factor VII. Aptitude for understanding or comprehending verbal instructions.
Factor VIII. Aptitude for a specific type of psychomotor task.

Factor I has been defined as a General Learning type aptitude. In view of the high loadings of both the Ammons Full Range Picture Vocabulary Test and G, (Learning ability), it seems quite reasonable that both measure an identical aptitude. This conclusion suggests that Hypothesis 1 is tenable.

V, (Verbal ability) is a composite of G (Learning ability) in the GATB. The V, (Verbal ability) loading was relatively high on Factor I and relatively low on Factor VII. In view of this, Hypothesis 2 seems acceptable.

Factor VI was defined as measurement of Numerical Ability. N, (Numerical ability) on the GATB showed the highest factor loading. The Wechsler arithmetic subtest did not load on this Factor. Conversely, Wechsler arithmetic subtest showed the highest loading on Factor V, defined as

an aptitude for Arithmetic reasoning. N, (Numerical ability) showed a relatively low loading on this Factor. In view of this, Hypothesis 3 is rejected as untenable.

Factor III was defined as measuring an aptitude for perceptual detail, especially in a likes-opposites kind of task. Both Part 6 of the Revised Beta Test and Q, (Clerical) on the GATB showed a high loading on this Factor. Based on this observation, Hypothesis 4 appears tenable.

CHAPTER IV

SUMMARY AND DISCUSSIONS

Summary

An experimental study leading to the development of a non-reading version of the General Aptitude Test Battery was carried out using 150 male inmates at the Oklahoma State Penitentiary as subjects. The subjects were selected by age and placed into three groups. Each subject had been administered the GATB within 90 days previous to the study.

The Ammons Full Range Picture Vocabulary Test, Form A; Part 6 of the Revised Beta Test; Coin Matching Test; Coin Series Test; and the Matrices Test were administered in order to ascertain and explore the possibility that these tests might serve as substitutes for reading tests currently in use in the GATB, B-1002. The results were subjected to factor analysis utilizing the varimax multiple rotation technique.

The findings and conclusions obtained from this study were:

1. The Ammons Full Range Picture Vocabulary Test showed high factor loading on a Factor interpreted as

General Learning Ability which might serve as a substitute for reading requirement tests now in use in the GATB that measures factor G, Learning Ability.

2. The Ammons Full Range Picture Vocabulary Test showed high factor loadings on the same factor that showed a high loading for the V, Verbal factor of the GATB.

3. The Wechsler Adult Intelligence Scale Arithmetic subtest did not show a significant loading on the same factor as did N, the Numerical in GATB. Numerical showed a high loading on another factor. This observation seemed to sustain the notion that arithmetic reasoning and fundamentals of arithmetic were not measured by the same factor. Further research in this area might prove fruitful.

4. In the present study, the research Coin Matching Test in use by the United States Employment Service showed more promise for measuring Numerical ability than did the research Matrices Test. The research Coin Series Test did not load significantly on either of the factors which were thought to tap numerical ability. Its use as a test for measuring Numerical ability seemed somewhat questionable in light of the results found in this study. The Coin Series Test showed a high loading on a specific factor which was not identified. In regard to this study, further research with this test seemed necessary before it could be accepted as a test for measuring Numerical ability.

5. Part 6 of the Revised Beta Test and Aptitude Q,

Clerical Ability both showed high factor loadings on the same factor. Because of the lack of alphabet items, the Revised Beta Part 6 seemed to represent more closely a non-reading test of the likes-opposites type that was generally thought of as measuring clerical aptitudes.

In summary, it appeared that certain non-reading tests in use today might well serve as substitutes for reading tests in the present form of the GATB, B-1002, and may tap similar or identical aptitudes. Such a non-reading version of the GATB would afford reliable measurement of vocational and occupational aptitudes for slow reading or illiterate individuals.

Discussion

In a factor analytic study, only those dimensions will be revealed along which there is a variation in both the measures and subjects and is relevant to that study alone. Varimax procedure extracts most of these common factors (Saunders, 1962). From the data obtained in this study, several conclusions may be made about non-reading tests and their use in the GATB.

Factor I loadings indicate the extraction of a general learning aptitude. Almost half of the 15 variables showed a significant loading and at least two of the three composites of G had high loadings, e.g., Verbal and Numerical. The highest loading of Ammons Full Range Picture Vocabulary Test seemed to substantiate the notion that

this instrument would serve as a reliable substitute for assessing aptitude G in the GATB. The Wechsler Arithmetic subtest showed a somewhat lower loading, yet acceptable as significant for assessing the Numerical portion of the G factor on the GATB.

The high loading of Verbal on Factor I suggested the contribution of some verbal aptitude in General Learning ability. While the Ammons Full Range Picture Vocabulary Test was primarily concerned with what was described as general intelligence, it was for the most part a test that required an understanding of the language in which it was administered. At the present time there is a preliminary form of Wechsler-type norms for the Ammons Full Range Picture Vocabulary Test from which an Equivalent I.Q. could be obtained. The loadings of the Ammons Test and V, (Verbal) on Factor I of this study confirmed Hypothesis 2.

The Wechsler Arithmetic subtest loading on Factor V indicated an Arithmetic Reasoning aptitude. The low loading of Numerical was not fully understood since a portion of this factor on the GATB was arithmetic reasoning, i.e., Part 6. On the other hand, the high loading of Numerical on Factor VI with an insignificant loading of the Wechsler arithmetic subtest was equally difficult to explain. Since Part 6 was a weighted contribution to G, a loading of G seemed plausible. One possible explanation for this discrepancy may lie in the fact that both of the tests that

comprised Numerical on the GATB were paper-and-pencil type tests while the Wechsler arithmetic subtest was a verbally administered test that required only conceptual manipulation rather than both conceptual manipulation and psychomotor (pencil manipulation) type tasks. The obtained results did not confirm Hypothesis 3.

The relatively high loadings of both Part 6 of the Revised Beta Test and Q, Clerical, implied that this was a factor that required similar type tasks. For the most part, this seemed to be a comparison of likes and opposites. While a likes-opposites type task was generally considered an aptitude necessary in clerical aptitude, the Revised Beta Part 6 was devoid of any linguistic influence. It had been this investigator's experience to be asked invariably if abbreviations were to be considered on Part 1, factor Q, on the GATB. This could imply something other than a requirement of differentiating between likes and opposites which might handicap the slow or non-reader.

The Matrices Test did not show high factor loadings on any of the 8 factors that were extracted. While this test showed significance according to the values set for this study on Factors I, III, V, and VII, the highest value was only .39 on Factor V. On Factor III, the likes-opposites factor, it loaded with a value of .35. It seemed inconsistent that the test results did not show a significant loading on Factor VI which had significant loadings in Numerical and Learning Ability. In the description of the Matrices

Test by Dvorak, Droege and Seiler (1965), there seemed to be some question as far as this study was concerned as to whether the Matrices Test did tap areas of Numerical ability.

The Coin Matching Test showed two significant factor loadings on Factors III and V. Factor III task requirements were basically a likes-opposites type test and Factor V was an arithmetic reasoning type task. In evaluating its potential as a test requiring numerical ability, the Coin Matching Test showed more promise than the Matrices Test.

The Coin Series had only one significant factor loading and that was on Factor VII. The Verbal and Matrices tasks showed somewhat lower loadings on this factor. It was interesting to note that Coin Series did not show significant loadings on either Factor V where Wechsler Arithmetic subtest had the highest loading or on Factor VI where Numerical had the highest loading. In this study, it seemed unlikely that the Coin Series Test was a test which required Numerical ability, unless it did so in a manner unlike what was traditionally thought to measure numerical ability. It was not understood what was being measured by Factor VIII. A relevant aspect might be found in the directions for administering the test. The author experienced great difficulty in the administration of the Coin Series Test because of the number of subjects who apparently failed to understand the instructions. While a number of subjects related that they did understand what they were to do, it seemed rather obvious to the investigator that they did not when

observing them at work. Reference had been made earlier to the bi-modal distribution of total scores on the Coin Series Test. Such a distribution suggested that many of the subjects either understood the directions with ease and received a high score or failed to understand them and made a low score. As long as thirty minutes were required to read and repeat the instructions and counsel with individual subjects. Several implications seemed evident concerning the Coin Series Test. The first concern was what was measured by Factor VII in this study, and the second raised the question as to whether the present instructions were too difficult and time consuming for economical group testing.

The mean scores obtained on the nine variables of the GATB showed some significant differences among the age groups. However, these differences were difficult to interpret since subjects in any of the three groups were administered the GATB at different times. It was observed during test administration that the older subjects in Group III asked fewer questions, but apparently did more poorly, than the younger subjects in Group I. The question of age and test performance seemed relevant in view of the fact that 8 significant differences were noted between Group I and Group III and only 5 significant differences between Group II and Group III. With the exception of performance on one test, arithmetic, the average scores were higher for the oldest age group.

Recommendations

The implications resulting from this study would suggest consideration of several aspects concerning a non-reading version of the GATB.

1. The Ammons Full Range Picture Vocabulary Test might well serve as a substitute test for measuring what is termed learning ability in the present form of the GATB, B-1002. While Form A of the test requires as long as thirty minutes to administer, the content of the Ammons Full Range Picture Vocabulary Test or a similar test may be utilized in a shortened version that is still a reliable instrument.

2. The Ammons Full Range Picture Vocabulary Test is a reliable instrument for measuring what is termed Verbal ability on the present form of the GATB. Further, there seems to be the implication that the verbal factor contributes to the factor that is measured by G, Learning Ability, and which is now a composite of G.

3. The Wechsler arithmetic subtest does not appear to measure arithmetic fundamentals as much as arithmetic reasoning. The failure of the arithmetic subtest to load highly on the same factor as Numerical tends to suggest the need for further research in this area. Further research might be concerned with what factor or factors are required to measure accurately an aptitude for Numerical ability.

4. The Coin Matching Test shows more promise of measuring Numerical ability than the Matrices Test.

Further, the Coin Series Test did not load significantly on either of the factors generally thought to tap Numerical or arithmetic ability. It seems apparent that further research should be concerned with the specific factor found in the Coin Series Test and the questionableness of the Matrices Test and Coin Matching Test as instruments to measure Numerical ability.

5. Part 6 of the Revised Beta Test seems to measure much the same aptitude as factor Q, Clerical on the GATB. Part 6, however, does not contain items such as abbreviations - which suggests a written language knowledge might be an aspect of the present Q factor in the GATB.

The overall implications of this study lead to some recommendations for further research. More conclusive results may be obtained by replicating this study with various groups other than incarcerated subjects. Variation of criteria other than age alone may be implemented in order to explore factor structure. Content of the tests used in this study may lead to research dealing with the isolation of tasks required for specific factors. And finally, while generally inconclusive because of the size of the sample in this study, there is the general implication that a non-reading version of the GATB can be made available in the not too distant future.

REFERENCES

Droege, R. C. USES, Washington, D. C. GATB norms for lower high school grades. Personnel Guidance Journal, 1960, 39, 30-35.

Dvorak, Beatrice J. The new USES General Aptitude Test Battery. Occupations. 1947, 26, 42-43.

_____. The General Intelligence Test Battery. Personnel Guidance Journal, 1956, 35, 145-152. (a)

_____. GATB in foreign countries. Journal of Applied Psychology. 1956, 40, 197-200. (b)

_____. Changing emphasis on occupational test development. Employment Service Review. August, 1965.

Dvorak, Beatrice J., Droege, R. C., and Seiler, J. New directions in U. S. Employment Service aptitude test research. Personnal Guidance Journal, 1965, 138.

Guilford, J. P. Fundamental Statistics in Psychology and Education. New York: McGraw-Hill, 1956, 538-539.

Hirt, M. Use of the General Aptitude Test Battery to determine aptitude changes with age and to predict job performance. Journal of Applied Psychology, 1959, 43, 36-39.

Horrocks, J. E. Assessment of Behavior. Columbus, Ohio: Merrill Books, 1964, 11.

_____. Assessment of Behavior. Columbus, Ohio: Merrill Books, 1964, 322.

Horst, P. Psychological Measurement and Prediction. Belmont, California: Wadsworth Publishing Co., 1966, 143.

Odell, C. E. Cooperative Research in aptitude test development. Educational and Psychological Measurement. 1949, 9, 396-400.

Munsterberg, H. Psychology and Industrial Efficiency. Cambridge, 1913.

Samuelson, C. O. The General Aptitude Test Battery in predicting success of vocational school students. Journal of Educational Research, 1956, 50, 175-182.

Saunders, D. R. Trans-varimax: Some properties of the ratiomax and equamax criteria for blind orthogonal rotation. American Psychologist, 1962, 17, 395-396.

Sharp, H. C. and Pickett, L. M. The General Aptitude Test Battery as a predictor of college success. Educational and Psychological Measurement, 1959, 19, 617-623.

Shartle, C. L., Dvorak, B. J. and Heinz, C. A. Ten years of occupational research, 1934-1944. Occupations, 1944, 7, 387-446.

Stevens, S. S. (Ed.) Handbook of Experimental Psychology. New York: Wiley, 1951.

Storrs, S. V. Evaluative data on the General Aptitude Test Battery. Personnel Guidance Journal, 1952, 31, 87-90.

Super, C. E. Comments on Dvorak's report. Personnel and Guidance Journal, 1956, 35.

Super, D. E. and Crites, J. O. Appraising Vocational Fitness by Means of Psychological Tests. New York: Harper and Row, 1962, 332.

United States Department of Labor. Guide to the Use of the General Aptitude Test Battery. Section II: Norms. Washington. 1962.

United States Department of Labor. Guide to the Use of the General Aptitude Test Battery. Section III: Development. Washington, 1962, 1.

Vernon, P. E. The Structure of Human Abilities. London: Methuen and Co., 1950, 21.

APPENDIX A

APPENDIX A

AGE DISTRIBUTION OF SUBJECTS IN SAMPLES

Group 1			Group 2			Group 3		
Age	Number	Percent	Age	Number	Percent	Age	Number	Percent
16	2	1.33	26	6	4.00	36	1	0.67
17	2	1.33	27	9	6.00	37	7	4.67
18	7	4.67	28	5	3.33	38	4	2.67
19	11	7.33	29	4	2.67	39	5	3.33
20	8	5.33	30	4	2.67	40	3	2.00
21	5	3.33	31	6	4.00	41	5	3.33
22	5	3.33	32	3	3.00	42	4	2.67
23	6	4.00	33	7	4.67	43	2	1.33
25	4	2.67	34	4	2.67	44	3	2.00
			35	2	1.33	45	4	2.67
						47	2	1.33
						48	2	1.33
						49	3	2.00
						50	2	1.33
						52	1	0.67
						53	1	0.67
						60	1	0.67
	N = 50			N = 50			N = 50	
	Age $\bar{X}$ = 20.28			Age $\bar{X}$ = 29.88			Age $\bar{X}$ = 42.70	
	SD = 2.29			SD = 2.81			SD = 5.11	

APPENDIX B

APPENDIX B

Raw Data for Each Subject by Age, I.D., and Test Variable

AGE	ID	G	V	N	S	P	Q	K	F	M	AR	RB	WA	MA	CM	CS
16	101	84	82	71	83	72	81	79	98	76	62	12	13	24	31	156
16	102	95	104	94	110	105	109	86	82	86	68	13	12	28	23	164
17	103	104	88	105	114	136	113	97	110	99	59	12	12	23	31	161
17	104	76	88	75	88	77	87	80	67	69	60	10	8	18	23	133
18	105	117	108	101	124	125	87	103	89	111	70	13	15	28	32	140
18	106	73	78	64	110	132	91	70	89	72	53	10	12	10	26	63
18	107	72	86	61	65	62	76	101	68	76	62	9	8	11	21	30
18	108	85	92	76	84	90	84	72	61	59	53	12	12	14	30	120
18	109	122	108	113	140	133	118	89	112	103	63	12	10	26	27	164
18	110	84	76	93	78	70	94	72	90	100	54	12	8	13	23	23
18	111	106	92	89	133	118	87	62	101	107	74	13	13	28	21	99
19	112	68	65	53	84	68	77	78	77	58	50	8	6	13	19	42
19	113	85	82	74	107	74	77	82	106	70	57	8	6	20	27	60
19	114	112	111	103	110	96	99	89	91	86	72	12	14	28	30	163
19	115	75	68	72	88	91	76	91	65	108	56	8	10	18	25	105
19	116	81	88	85	104	122	100	95	83	72	54	10	10	24	30	44

AGE	ID	G	V	N	S	P	Q	K	F	M	AR	RB	WA	MA	CM	CS
19	117	102	92	94	133	106	100	111	99	110	63	14	11	20	32	60
19	118	86	84	68	104	106	86	82	77	73	55	9	4	15	19	91
19	119	81	80	78	91	105	90	86	79	82	56	11	7	7	23	56
19	120	83	90	79	97	111	103	82	93	90	66	13	7	23	23	130
19	121	104	80	95	124	129	88	95	66	79	59	10	7	11	26	33
19	122	82	74	84	84	105	108	107	86	116	68	12	8	23	24	95
20	123	91	102	69	124	139	69	101	72	104	69	8	11	16	22	54
20	124	106	84	109	127	108	96	89	78	91	52	13	17	28	26	153
20	125	101	94	101	101	115	101	99	83	119	72	9	14	22	24	114
20	126	66	84	60	78	75	96	70	85	86	47	10	6	9	17	48
20	127	69	86	58	84	87	69	86	81	113	63	10	7	5	16	123
20	128	50	63	40	58	32	72	78	58	46	22	10	5	8	18	22
20	129	99	98	100	117	109	93	82	104	81	70	10	12	26	32	137
20	130	82	82	71	107	155	114	113	99	100	62	12	5	7	27	83
21	131	84	82	96	84	102	89	84	51	70	57	10	12	16	28	59
21	132	70	82	63	78	77	88	53	85	76	67	9	9	16	24	58

AGE	ID	G	V	N	S	P	Q	K	F	M	AR	RB	WA	MA	CM	CS
21	133	98	94	88	127	125	113	97	81	119	62	11	8	21	25	160
21	134	103	106	109	78	117	113	95	100	109	70	10	11	26	26	137
21	135	95	86	92	117	90	96	101	114	62	68	11	5	15	20	39
22	136	73	76	72	71	91	86	76	83	94	47	9	9	8	25	23
22	137	103	96	103	117	94	122	105	92	86	64	10	12	26	26	159
22	138	105	82	111	117	89	88	82	71	112	59	10	12	23	31	158
22	139	108	94	86	150	145	118	120	116	136	68	12	11	24	28	163
22	140	94	92	90	117	97	108	105	89	116	63	12	8	14	27	110
23	141	94	106	77	117	89	87	76	77	93	63	9	8	18	18	109
23	142	115	115	111	124	121	124	122	73	76	77	10	11	24	32	165
23	143	67	76	57	84	94	90	120	94	97	31	12	5	16	19	28
23	144	94	90	80	120	102	99	87	81	103	61	12	7	17	20	131
23	145	100	98	95	107	104	103	120	110	125	67	11	11	23	12	120
23	146	81	78	82	94	109	97	80	98	100	59	12	8	16	32	143
25	147	103	92	103	104	99	114	101	89	121	68	9	5	18	26	8
25	148	93	72	84	137	99	82	80	84	76	63	12	12	23	30	76

AGE	ID	G	V	N	S	P	Q	K	F	M	AR	RB	WA	MA	CM	CS
25	149	97	86	96	124	129	105	91	96	87	70	11	15	24	26	93
25	150	94	92	78	124	120	87	111	86	70	67	7	11	22	24	87
26	201	90	106	92	84	127	105	107	86	113	70	12	9	14	32	158
26	202	90	80	76	117	87	97	78	84	88	56	9	9	25	30	91
26	203	65	74	63	78	74	77	82	75	81	28	10	5	5	21	59
26	204	86	98	105	133	84	101	93	67	93	53	9	5	5	18	40
26	205	117	100	119	127	129	119	111	110	106	76	14	14	22	30	163
26	206	95	80	82	124	94	89	74	119	98	69	9	10	15	19	32
27	207	109	121	97	107	94	107	128	101	95	83	14	11	16	29	131
27	208	78	90	77	81	73	78	109	79	76	69	10	8	17	21	146
27	209	90	86	78	110	90	90	97	98	86	57	10	6	20	20	113
27	210	101	98	108	133	109	101	103	124	127	75	12	14	25	31	144
27	211	110	102	89	97	100	93	109	92	87	63	12	9	17	32	78
27	212	84	92	65	97	80	76	70	75	90	58	10	6	9	17	44
27	213	80	90	87	88	93	96	95	66	71	67	12	9	17	21	80
27	214	78	70	61	120	86	79	74	75	132	54	9	8	9	19	100

AGE	ID	G	V	N	S	P	Q	K	F	M	AR	RB	WA	MA	CM	CS
27	215	88	76	92	107	126	104	99	76	83	57	13	9	13	32	158
28	216	113	102	120	91	93	113	101	70	96	70	12	12	19	32	40
28	217	92	82	98	114	94	89	115	127	130	67	9	10	19	29	77
28	218	116	108	109	137	106	101	86	57	100	65	12	11	22	32	163
28	219	121	125	103	130	102	117	109	80	118	80	12	11	27	31	150
28	220	91	92	90	107	106	110	101	102	119	57	13	10	17	27	135
29	221	93	88	84	107	88	96	86	0	17	64	10	9	15	24	127
29	222	79	92	84	65	76	84	64	58	15	59	8	9	2	26	27
29	223	110	96	113	104	88	108	118	81	108	72	13	14	24	32	152
29	224	96	92	88	114	98	86	103	72	91	76	10	11	28	29	25
30	225	96	68	90	104	94	101	128	111	115	76	11	11	13	24	61
30	226	86	92	90	88	85	80	86	64	82	69	10	12	10	21	50
30	227	101	92	76	140	107	79	103	93	116	66	12	10	14	30	18
30	228	82	80	80	88	70	81	101	60	84	65	9	7	9	21	15
31	229	121	106	121	133	129	107	97	116	115	68	10	16	26	31	148
31	230	88	96	82	78	69	86	70	82	99	68	9	11	4	22	26

AGE	ID	G	V	N	S	P	Q	K	F	M	AR	RB	WA	MA	CM	CS
31	231	92	88	94	101	90	98	101	62	47	61	12	11	21	31	41
31	232	122	98	108	124	96	114	122	100	107	74	10	9	17	28	140
31	233	69	90	67	74	64	82	109	53	61	62	9	11	17	16	80
31	234	83	80	90	81	98	105	113	52	80	64	12	9	19	31	77
32	235	90	88	87	124	68	88	107	77	107	61	8	10	21	25	53
32	236	69	66	46	68	78	62	87	67	95	49	10	9	11	30	26
32	237	122	106	121	137	92	98	67	64	92	68	12	13	17	28	162
33	238	96	94	85	94	109	104	120	82	108	69	12	13	28	29	127
33	239	132	127	124	127	108	131	101	80	83	77	14	16	25	21	162
33	240	83	88	71	97	96	90	95	93	111	65	12	9	26	32	31
33	241	57	70	58	74	65	70	130	74	65	55	8	6	13	15	27
33	242	88	90	80	88	87	82	126	84	103	62	10	12	11	31	38
33	243	77	72	70	81	67	79	60	48	56	58	10	8	5	16	8
33	244	81	76	79	110	88	84	82	92	91	65	10	9	7	20	34
34	245	75	74	85	88	89	90	87	52	97	52	10	11	8	23	17
34	246	80	90	83	124	125	91	118	72	94	69	10	9	14	24	28

AGE	ID	G	V	N	S	P	Q	K	F	M	AR	RB	WA	MA	CM	CS
34	247	62	70	61	74	89	87	84	72	68	56	10	9	14	26	28
34	248	74	74	78	74	80	76	113	64	93	31	8	6	5	15	19
35	249	115	115	105	97	92	103	76	84	75	77	12	12	34	43	91
35	250	118	123	115	104	84	132	99	73	114	81	11	11	20	31	101
36	301	58	80	42	71	51	76	76	59	67	53	7	5	10	15	17
37	302	72	78	56	107	77	94	74	89	70	65	8	7	6	19	40
37	303	71	82	63	81	91	98	107	77	93	65	7	7	8	25	78
37	304	105	96	99	124	91	104	132	108	131	76	9	7	17	28	142
37	305	69	86	63	68	71	91	49	46	54	65	11	10	7	32	20
37	306	77	94	63	84	72	94	76	77	72	62	12	10	10	31	40
37	307	96	104	88	104	106	117	58	64	69	74	10	12	25	31	73
37	308	111	100	91	124	97	100	132	106	100	71	12	13	24	30	26
38	309	92	92	94	97	95	107	62	96	100	70	11	10	13	32	119
38	310	93	78	97	107	87	82	93	73	59	64	9	9	13	24	66
38	311	80	68	90	97	61	87	89	61	71	67	9	9	10	20	38
38	312	84	88	76	91	72	80	84	69	96	72	8	8	13	18	20

AGE	ID	G	V	N	S	P	Q	K	F	M	AR	RB	WA	MA	CM	CS
39	313	73	74	67	81	65	71	93	52	90	62	10	5	10	25	35
39	314	84	94	82	84	77	97	82	104	103	72	10	12	23	29	110
39	315	81	86	88	68	96	108	120	78	135	64	12	11	9	25	48
39	316	82	76	68	97	82	77	58	56	43	50	8	7	10	17	72
39	317	76	90	60	104	58	97	91	82	82	66	9	5	17	19	25
40	318	97	94	88	114	83	94	84	77	94	60	10	12	20	30	120
40	319	92	88	96	104	101	108	111	87	117	64	14	13	20	27	138
40	320	107	108	101	117	110	105	97	58	89	76	12	13	26	27	159
41	321	85	72	97	127	94	86	62	92	83	69	9	8	15	27	42
41	322	62	90	48	74	72	62	58	73	61	62	7	7	11	20	31
41	323	118	98	104	97	73	80	95	84	79	69	8	11	18	19	18
41	324	83	80	71	110	89	97	101	89	71	65	11	6	12	20	82
41	325	93	94	99	84	87	98	76	101	53	62	9	12	10	23	46
42	326	145	125	143	124	95	124	95	59	63	82	12	17	29	32	164
42	327	87	82	82	94	83	79	86	78	95	69	10	11	18	25	30
42	328	94	88	96	110	83	99	82	73	77	75	12	12	19	25	25

AGE	ID	G	V	N	S	P	Q	K	F	M	AR	RB	WA	MA	CM	CS
42	329	128	123	114	117	102	124	136	99	133	79	13	16	25	33	113
43	330	68	72	53	68	35	51	56	25	63	45	8	8	6	5	11
43	331	71	80	65	91	59	72	53	62	58	55	8	7	6	16	29
44	332	74	80	71	78	84	78	95	78	59	52	9	7	13	17	21
44	333	94	96	99	74	81	103	111	85	73	76	13	12	24	28	14
44	334	69	70	84	55	80	78	76	86	92	58	8	8	9	10	34
45	335	55	65	62	65	68	71	53	82	84	48	7	7	12	23	16
45	336	59	72	69	58	52	61	43	56	58	53	9	10	7	19	23
45	337	75	86	63	88	72	87	89	80	101	70	9	6	14	19	32
45	338	71	80	60	97	92	69	95	89	83	64	9	9	6	30	24
47	339	81	80	78	74	53	72	76	68	56	60	6	5	4	12	29
47	340	79	84	75	91	84	82	97	84	91	66	9	11	13	24	68
48	341	83	86	86	74	98	84	101	62	71	68	9	11	14	8	15
48	342	73	76	73	81	71	98	53	78	81	66	7	12	13	18	19
49	343	99	96	95	91	73	78	72	52	59	63	9	13	20	27	84
49	344	59	78	58	61	76	52	82	67	76	63	7	4	8	16	15

AGE	ID	G	V	N	S	P	Q	K	F	M	AR	RB	WA	MA	CM	CS
49	345	82	74	50	94	85	103	86	65	60	74	10	10	10	17	11
50	346	111	127	102	120	91	120	117	123	123	80	14	14	28	31	163
50	347	91	96	92	107	83	107	82	48	62	74	8	9	12	16	18
52	348	84	80	59	58	88	75	115	93	89	64	9	10	12	19	34
53	349	97	88	99	88	62	97	62	76	46	71	10	16	7	24	18
60	350	81	68	92	91	55	90	55	56	47	70	10	10	8	16	7