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THE PRIMARY MENTAL ABILITIES
OF
SPECIAL GROUPS OF STUDENTS
ATTENDING
THE KILBOURN JUNIOR TRADES SCHOOL

by

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CHAPTER I

THE PROBLEM AND BACK GROUND LITERATURE

In recent years the statistical techniques of multiple factorial analysis have been applied to the problem of intelligence measurement. Studies headed by Louis Leon Thurstone of the University of Chicago and Thelma Gwinn Thurstone of the Bureau of Child Study in Chicago have resulted in the isolation of primary factors or abilities which contribute to the intelligence of the individual. The researches on the primary mental abilities had as their first purpose, the identification and definition of the independent factors of mind. As the factors became more clearly indicated by successive studies the investigators turned to the construction of a set of tests which would aid the school in its testing and guidance program.[1]

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[1] L.L. Thurstone and T.G. Thurstone, Manual for The Chicago Tests of Primary Mental Abilities For Ages 11 to 17. p. 3 Washington D. C.: The American Council on Education 1941

The following study utilized both the tests and theories of primary mental abilities resulting from these experimentations.

Statement of the problem. The purpose of this study is to evaluate the primary mental abilities of special groups of students at The Kilbourn Junior Trades School as measured

by the Chicago Tests of Primary Mental Abilities.

Definition of terms. In the statement of the problems there are two phrases which require clarification.

1. Primary Mental Abilities are those factors the Thurstones define as making up intelligence and which are measured in the test used.

2. Special groups are made up of students who demonstrate inconsistencies:

a) in their I.Q. between verbal and non verbal measurements as indicated by the California Test of Mental Maturity.

b) between mental age and reading achievement level as measured by the California Test of Mental Maturity and The Progressive Achievement Tests.

Nature of the problem. The Kilbourn Junior Trades School is an institution which harbors many of the educational misfits of the city. Boys who have proved failures in regular classes for a multitude of reasons have been sent to this school. The hetrogenous group in attendance includes: (1) students who are intellectually and academically inferior; (2) students who have been transferred after failure to make social adjustments at other schools; (3) students who have been afflicted with some ailment which has affected intelligence and; (4) students whose makeup is a combination of the above. Thus when these individuals were unable to make satisfactory adjustment in the regular city schools,

principals and parents selected a trade school type of curriculum as an answer to such social and educational problems and hastened to expedite transfers.

To determine grade placement every student is given a California Test of Mental Maturity and a Progressive Achievement Test. On the basis of these test scores and past school record, the student is placed in the seventh, eighth or ninth grade.

With a group so complex the problem of meeting educational needs becomes a difficult one. One of the teachers expressed it as being primarily a matter of maintaining classroom discipline rather than a matter of teaching. Meeting the educational needs of the student becomes easier if he falls into some pattern. If an individual has a mental age of approximately 12-0 for both verbal and non verbal intelligence test scores and demonstrates 7th grade achievement, either by his class work or a generally accepted battery of achievement tests, a curriculum can be prescribed to meet his educational needs regardless of the number of years he has been retarded. However, at the Kilbourn Junior Trades School there are many who are so varied in their several abilities that it is difficult to define their educational needs. The previously defined groups require further study before adequate conclusions can be determined.

Do those students who are superior in verbal intelligence

show a difference in primary mental abilities from those who are superior in their non-verbal intelligence test scores? Do students who read on a level comparable to their mental age demonstrate any superiority in primary mental abilities to those who are inferior readers? How do these students compare in primary mental abilities with those the Thurstones tested? In which factors do they appear unusually inferior; in which do they compare favorably with the group which the Thurstones used to establish norms? Do these groups show particular patterns in their primary mental abilities profile? These are some of the questions this study considers. Since groups are small and subject to selectivity this study attempts to throw a little more light on the subject rather than serve as an answer to the educational problems involved.

Nature of the literature in the field. It was originally intended, in the process of reviewing the literature in the field, to discuss the various studies related to this investigation. However, a close analysis of the various reference sources revealed no data pertinent to the design of the present problem. Thus this investigation is a pioneer attempt with no background data available for direction.

It was thought worthwhile, however, to discuss the theoretical basis of Primary Mental Abilities, since such knowledge is necessary for an understanding of what was done in this study and what results might mean. This discussion

concludes the first Chapter. Also, a part of the background material is found in the contents of chapter two, "The Kilbourn Junior Trades School." The philosophy upon which this school was organized is valuable information because of the institutions present unsettled status and because it might offer a clearer picture of the problem involved in the study.

The theoretical basis of primary mental abilities. It was not until after the first World War that psychological and aptitude tests made great strides as a part of the educational program. The Army Alpha[2] drew the attention and

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[2] For an excellent discussion of the Army Alpha see Garrett, Henry E., Great Experiments in Psychology, pp. 31-59, New York: D. Appleton-Century Company, 1941.

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interest of American educators to the place of testing in our school program. As a direct result many psychological examinations using the pattern of the Army Alpha were constructed. However, according to Dr. L. L. Thurstone, educators discovered that a single test score was vague and unsatisfactory as a comprehensive description of a student. They realized that the single score was not adequate as a means of finding individual differences in the mental makeup of students. Prediction of success was not involved in a single ability but rather in a combination of several abilities. Dr. Thurstone stated,

> "For many years psychologists have described a person's mental endowment by a single index of

intelligence such as the intelligence quotient--the familiar I.Q." But it is well known among teachers and employers that men may have the same general level of mental ability and yet be totally different as to their aptitudes and potentialities, and therefore the single intelligence index is inadequate for the purpose of describing mental endowment.

It has been found necessary to use, in addition, other indexes of special abilities which cannot be represented by any single index of intelligence. Well known among such abilities, for example, is musical talent, which is really a complex of many abilities. Mechanical aptitude is another well known complex of abilities that cannot be represented by any single index of intelligence such as the intelligence quotient should be discontinued because of its logical inconsistencies."[3]

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[3] Thurstone, L.L. "Testing Intelligence and Aptitudes," Hygeia, 23:32-6, January, 1945

Sir Francis Galton (1822-1911) is credited with the first sustained attempt to measure intelligence. He attempted through experimentation to determine the differences in mental endowment in individuals by estimating their proficiencies.

The correlational techniques were originated by Galton, who handled them in a descriptive manner. Since then studies of correlation have given rise to a sound statistical technique. With the great increase in intelligence tests it was found that correlations between tests which were supposed to be indicies of general intelligence were far from perfect.

"It was concluded: (1) that no test is in any sense a pure meausre of the postulated general

> intelligence and (2) that an appreciable part of test performance is subject to fortuitous experimental error. The alternative was to consider intelligence as a complex of many distinct abilities. A third possibility which has some defenders is that intelligence is determined by thousands of factors that function without any pattern or groupings."[4]

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[4] Thurstone, L.L., "Theories of Intelligence" Scientific Monthly 62:101-12 February 1946

Spearman made a major contribution in his paper on the relations of psychological tests that had been given to the same individual. In 1904 Spearman concluded that there existed a single intellective factor which correlations indicated under certain conditions. This single intellective factor he denoted by the letter "G". This resulted in his famous Two Factor Theory. According to Spearman, each test is composed of only two factors; the "G" factor which is common to all test and a specific factor restricted to each test.[5]

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[5] Spearman, C., The Abilities of Man, New York: Macmillan Co., 1927, pp. 415.

This theory gave rise to many lively controversies. Until 1930 Spearman's theory was passively accepted, but as tests became more plentiful and more varied in makeup instead of the "general pattern" of the past, educators found Spearman's general intellective factor inadequate. With even the

best controls Spearman's theory was inadequate to account for observed relations among experimental tests. When other factors were acknowledged they had been termed disturbers of the fundamental relations of Spearman. Now the theory was changing.

In 1930 the emphasis in investigations was shifted.

> "Instead of looking for a single intellective factor common to a series of tasks, the investigation centered about discovering how many factors or abilities were represented by these tasks and further to identify the nature of these abilities. Spearman's method of analyses for a single factor had to be extended to the "N" dimensional case for any number of factors. During the last ten years much experimentation has been carried out using these methods which have been developed."[6]

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6 Thurstone, L.L. "Theories of Intelligence" Scientific Monthly 62:104 February 1946

Chief proponents of this approach are Thurstone and Hotelling. These men usually found, when working with batteries of tests, that if the content was quite varied there appeared groups of intellective factors rather than a single intellective factor. Their method then, was not one of statistically determining a single common factor which could be defined.

The first major experiment based on this new theory using the "N" dimensional method of factor analysis took place in 1934. The details of this experiment are described in Chapter Three.

The method of determining these factors is the reverse of plotting a typical diagram. Instead of having an X and Y axis on which to plot points, the factor problem reveals the points or configuration, and the investigator must identify the axes which represent the abilities or factors. The problem is to locate the axes so as to give a sound, scientific interpretation of the test results.[7]

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[7] For a more complete explanation of this approach see Thurstone, L.L., The Vectors of Mind Chicago: University of Chicago Press 1935 pp. 266

Factors did not participate equally in all tests. To make up a test battery it was necessary to select those tasks which were a test of a particular ability while other abilities were almost absent. This called for additional experiments carried out on groups of people who differed widely in age and education. Final interpretation of all analytical results, thus, consisted in discovering the nature of the ability shown to be present in one set of tasks and absent in another.

In 1938 Dr. L. L. Thurstone's "Test for Primary Mental Abilities" was published by the American Council of Education. It was labelled "Experimental Edition". This test was for a high school and college freshman. It is now out of

print.[8] The 1941 edition of the Chicago Test of Primary

[8] For a discussion of this test see Buros, Oscar K. 1940 Mental Measurements Yearbook Arlington Va: Gryphon Press 1945 P. 256

Mental Abilities is used in this study. Shortened forms have recently been put out by Science Research Associates. They also publicize the use of the test in combination with the Kuder Preference Record so that one can get a picture of abilities as related to interests. A more complete analysis of the test follows in the third chapter.

The question has been raised as to whether any of the primary factors that have been identified represent a modern form of the central intellective factor that Spearman postulated in 1904. Thurstone summarizes the question as follows, "There seems to exist a large number of special abilities that can be identified as primary by the factorial methods, and underlying these special abilities there seems to exist some central energizing factor which promotes the activity of all these special abilities."[9]

[9] Thurstone, L.L. "Theories of Intelligence" Scientific Monthly 62:112 February 1946

Besides the theories of Spearman and Thurstone, Karl

Holzinger[10] has proposed the Bi-Factor theory as an extension

10 Holzinger, Karl J. assisted by Frances Swineford and Harry Harman, Student Manual of Factor Analysis Chicago: Statistical Laboratory, Department of Education, University of Chicago, 1937 pp. 106

of the Two-Factory theory. His theory makes use of a single general factor common to all tests, specific factors restricted to a single test, and group factors common to a group of tests which have the same underlying common elements restricted to the tests as a group.

The basis of factorial analysis. It is not the intention in this thesis to explain the mathematics upon which the factorial analysis is based. However, the basic assumptions of factor analysis have been excellently summarized by both Dr. Thurstone in his first monograph and by Dr. Shanner in his doctoral dissertation. For those interested in a basic explanation Dr. Shanner is herewith quoted. For a detailed explanation related to construction of this intelligence test Dr. Thurstone's monograph is recommended.[11] Dr.

11 Shanner, William Maurice, "Primary Mental Abilities and Academic Achievement" pp. 5-7 Unpublished doctor's thesis. Chicago Graduate School, University of Chicago, 1944 and Thurstone L.L. Primary Mental Abilities Psychometric Monographs Number 1, pp. 102. Chicago: University of Chicago Press 1938

Shanner explains,

> "The principal problem of factor analysis is that of isolating and identifying factors or abilities which

underlie a battery of tests. The first step in the solution of the problem is to give the battery of tests to a group of individuals and to calculate the intercorrelations among the tests. The correlations, if they are significant, between various tests are evidence of some interlinkage in the elements involved in the test situations. This inter-linkage, however, is indeterminate for it may mean the existence of common content in the test situations or the presence of positive correlations between different aspects of the test situations with underlying abilities.

...This interlinkage which is involved in test situations constitutes the basis for postulating a common factor or factors to underlie the tests. The degree to which an individual possesses the underlying factor or ability which may be assumed to underlie all or only a few of the tests may be estimated by the following equation:

$$(1) \qquad A_i = a_1 s_1 + a_2 s_2 + a_3 s_3 \ \ldots$$

where A_i is the estimated standard score of the $\underline{i}$ the individual for the underlying ability or factor $\underline{A}$; $a_1 a_2 a_3 \ldots$ are the factor loadings or weights of ability or $\underline{A}$ in test 1, test 2, test 3, and so on; and s , s , s , ... are the standard score of $\underline{i}$ the individual on the respective tests. The standard score values s_1, s_2, s_3 ..., are readily obtained from an administration of the test battery. The factor loadings a_1, a_2, a_3, ... for each test must be determined by formulae from the intercorrelations among tests.

The correlation between two tests $\underline{S}$ and $\underline{T}$ may be expressed in terms of factor loadings of the general and group factors which underlie the two tests:

$$(2) \qquad r_{ST} = a_S a_T + b_S b_T + c_S c_T \ \ldots$$

where a_S, b_S, c_S, ---are factor loadings of the various general and group factors for test $\underline{S}$ and a , b , c , ... are the respective factor loadings for test $\underline{T}$.

The weights or factor loadings a, b, c, ... of the various abilities found in test $\underline{S}$ fulfill the conditions set by the following equation:

$$(3) \qquad \underset{\text{reliability}}{\sigma_S^2} = \underset{\text{communality}}{a^2 + b^2 + c^2 + \ldots} \quad \underset{\text{uniqueness}}{s^2 + t^2} = 1$$

where σ^2_s is the unit test variance S; a, b, c, ... are factor loadings of the various general and group factors; s is the factor weight of the specific factor; and t is the weight of the unreliability factor in test S. The amount of units test variance of test S due to common factors is called communality; the amount due to the specific and unreliability factors is referred to as the uniqueness; and the communality plus the specific factor is known as the reliability of the test.

The fundamental concepts of factor analysis have been presented in the foregoing discussion. From the discussion it is evident that the factor methods seek to transform the original table of correlations for a large number of tests into a much smaller number of factors whose loading for each test will satisfactorily reproduce the correlations in the original table. Thus, the factorist simplifies the problem of interpreting a large battery of tests by using a few factors to explain the relationships existing among the large number of tests."

The method employed. The records at the Kilbourn Junior Trades School showed that many of the students demonstrated the inconsistencies previously mentioned (p.2). It was believed that these students would show great variability in their primary mental abilities. The writer reasoned that if a preliminary study would reveal significant differences between any two primary mental abilities then a more extensive and intensive study would be justified. The pre-test group of fourteen students proved to be significantly superior in reasoning ability when compared with the memory factor. This was the "go-ahead" signal. An additional group of twenty students were tested. Of these, two were eliminated because it was felt that their inferior reading ability invalidated their test results. One other was eliminated when

he was involved in a delinquency and was unable to complete the testing program. Thus there were 31 students whose abilities were evaluated.

Throughout the analysis, group study techniques were employed in preference to evaluation of individuals. Several different avenues of approach were employed in making the evaluation. In terms of the total group of 31, the following method was employed: (A) An anlysis was made to determine how these students compared with the 18,000 children in Chicago schools upon whom age norms were established. (B) The primary mental abilities of the total group were evaluated. This was accomplished by determining whether the differences found in scores between the various factors were significant.

For the remainder of the study sub groups taken from the total group were employed. These groups were formed on the following basis: Group 1 was comprised of individuals who scored superior in their language intelligence as compared to non language scores. Group 2 was comprised of those individuals whose results were the opposite of group 1 (i.e., superior in non language to language I.Q.). Group 3 rated higher in reading age as compared with mental age and Group 4 had a higher mental age than reading age.

The next step was to evaluate the primary mental abilities of these sub groups. (C) In groups 1-2-3-4 the

primary mental abilities were compared as was done in B above. This involved the determination of the degree of difference between the six factors included in the test. From each of the four groups, an individual was then selected who was believed to be most typical of his group. The pattern he presented was described. (D) Then individuals in groups one and two were matched on the basis of mental age and a comparison was made to determine in which factors or abilities one group surpassed the other. The degree of significance of the differences was computed. (E) Finally step D was repeated with groups three and four. Thus the special groups were analyzed both in terms of their own primary mental abilities and also in terms of how they compared with their opposite groups.

CHAPTER II

THE KILBOURN JUNIOR TRADES SCHOOL

The Kilbourn Junior Trades School was organized as a pre-vocational school to meet the needs of certain students. At the time no other educational institution was fitted to provide an adequate education for these boys. In this chapter both the original objectives and a changing trend of thought are pointed out.

The present status of the school. In the past year the school board and the community have discussed and debated the place of the Junior Trades School in the school system and in the community. Superintendent Goodrich has questioned the value of such segregation. Some action has been taken to close such institutions in Milwaukee. However, the school board, in considering such closure of the Junior Trades School for Girls, has voted to continue these girls' schools for another year. No final decision, though, has been made on the permanent status of Junior Trades Schools. If it is finally decided to eliminate this form of educational institution the procedure will probably be one whereby no new students will be accepted, and enrollment will decrease.[12]

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[12] According to Edward Batterman, who was appointed principal of Kilbourn Junior Trades School in February 1948, action to close any of the Milwaukee Junior Trades Schools has been tabled for consideration at some later date.

This uncertain status makes doubly important the necessity of knowing more about the primary mental abilities of the special students. Not only is there a necessity for knowing what to prescribe for the present group, but knowledge of these mental abilities might help meet educational needs of the special students situated in the regular Junior High School.

The history and objectives of the school. The Kilbourn Junior Trades School was established in 1923. It was then known as a pre-vocational school. On June 3, 1924 School Board Director Engelke presented a report for the Special Committee on Pre-Vocational Schools.[13] In this report he

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[13] Proceedings of the Board of School Directors July 1, 1923-June 30, 1924, p. 675. Milwaukee, Wis: Radtke & Kortsch Co. 1924

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pointed out that pre-vocational schools were established for the following students:

1. Those out of step with the work of the regular school, either as a result of a natural distaste for school work or for other causes.

2. Those who are considerably over age and often physically developed to an unusual degree, considering the stage of school progress.

3. Those whose active natures incline them to breeches of discipline.

4. Those who are often spoken of as more inclined to physical activity than to academic effort.

5. Those whose home environments are such as to afford them only a limited outlook upon life giving them insufficient training in habits and duties of citizenship.

6. Those whose inclinations and intent is to leave school early to enter the employment field.

7. Those of foreign birth or of parents of foreign birth who have not had the advantages of an English mother tongue.

To meet the needs of these students Director Engelke recommended that the schools provide opportunities for a healthy outlet of activities for the physically overactive. In his plan he suggested an athletic program and shop courses in addition to the regular academic program. In order to stimulate thinking power Mr. Engelke recommended that adequate schools be provided. Among the facilities specifically mentioned were laboratories, a library, a gymnasium, a drawing room and a room where elementary commercial work might be taught. The pre-vocational schools were to be authorized to offer seventh, eighth and ninth grade work which was preparation for the tenth grade.

The following entrance requirements were set forth:

1. Any person who shall have satisfactorily completed the regular sixth grade course may be assigned by the

central office as a pupil in Pre-Vocational School upon petition of the parents and approval by the Assistant Superintendent in charge of schools of the district in which the child resides.

2. Fourteen year old grade children (other than Special C pupils) may be assigned to a preparatory class in a Pre-Vocational School by the central office upon the recommendation of the losing principal and the supervisor of special classes. The transfer order was to be initialed by the superintendent or one of his assistants. In a handbook distributed to inform teachers of the opportunities and requirements of special schools the following revisions and additions were noted.[14] The second requirement was re-

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[14] Life Advisement Council of the Elementary Schools, Provisions for Special Education in the Milwaukee Public Schools p. 12, Milwaukee, Wisconsin: School Board of Milwaukee, 1936

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vised to include those who were to become fourteen during the semester. Also included were (3) boys and girls of junior high school age who look forward to a trade or technical high school training and, (4) graduates of any public or parochial elementary school who wished to attend the ninth grade.

At a meeting of the Board of School Directors on March 3, 1931, Director Westphal introduced a resolution proposing a new combination junior and senior technical high school on

TABLE 1[15]

VIEWS OF NORTH SIDE PRINCIPALS

I. Attitude toward proposed school:

In favor of	23
Opposed	1
Doubtful	1
Indefinite	1
No opinion	2
Total	28

II. Type of school favored:

A Boys' Technical High School	16
A Technical High School	2
A Trade School only	2
A Boys' Tech and Prevocational School	3
Make Kilbourn a Junior Tech	1
A Prevocational School	1
A school better suited to a slow type	1
No opinion	2
Total	28

III. Location favored:

Northwest side	9
North Side	7
Northern part of city	1
Northern half of city	1
Central	2
Near North Avenue	1
North Avenue and 27th Street	1
Near Capitol Drive and west of Green Bay Road	1
Two miles west or river	1
Garden Homes or along Milwaukee River	1
West of Kilbourn	1
No opinion	2
Total	28

[15]Ibid., p. 5.

the north side of the city. His resolution proposed that the Kilbourn Pre-Vocational School be made a part of the new school. A committee was appointed to analyze the problem. In May 1931 a report was made by the committee.[16] In general, most of the city principals were against the

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16 Committee to Study the Need of a North Side Technical High School, Technical Educational Facilities, pp. 49. Milwaukee, Wis.: School Board of Milwaukee, 1931

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present location of the Kilbourn Pre-Vocational School as the site of a new school though they definitely did believe another technical high school should be erected. (See Table 1)

The committee in its investigation had principals ask a representative number of boys why they chose the school they did. Table two is an excerpt from that part of a larger table which covers the Pre-Vocational Schools. The reasons given have been grouped under several divisions. The figures in parentheses at the head of each group represent the total of the group. Other figures not in parenthesis indicate the number of times the particular reason was mentioned. It should be noted that the total number of reasons given is greater than the number of students who replied. This results from the fact that some individuals gave as many as three or four reasons.

Group A includes all reasons given which have to do

with the appeal of industrial subjects as such. Most boys, according to this report, enrolled in prevocational school because of interest in shop or trade subjects. "Apparently no small number of boys have enrolled in prevocational school under the impression that they could learn a trade there. This erroneous notion is often obtained through friends and others not accurately informed as to exact nature of these schools. To many persons shop and trade appear to mean the same thing. For these boys it is certain that a junior technical high school would serve equally as well."[17]

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17 Ibid., p. 20

The study revealed that boys in prevocational schools frequently advance the same reasons as boys in Technical High Schools. The desire to learn a trade showed a gross misapprehension on the part of these boys. Out of this grew a recommendation that prevocational schools be called junior technical or junior trade schools since the name would probably be more descriptive of the types of work which most of the boys of the school and their parents expect to find there."[18] As a result of this recommendation the boys

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18 72nd Annual Report of the Superintendent of Schools, Our Techs June, 1931, p. 45 Milwaukee, Wis: Radtke Bros. & Kortsch Co. 1931

TABLE 2[19]

REASONS GIVEN FOR ENROLLING IN PREVOCATIONAL SCHOOL

REASONS	Pre-Voc. Total 291	
	No.	%
A. Appeal of industrial subjects:	(221)	(30.3)
1. Foundation for trade		
2. Desire to learn a trade	114	15.6
3. Explore various occupational lines	32	4.4
4. Increase opportunity for immediate employment	40	5.5
5. Increase opportunity for getting job and for future success	8	1.1
6. Interest in trade subject	1	.1
7. Desire shop work	14	1.9
8. Desire to make things	2	.3
9. Learn to use tools and machinery		
10. Natural inclination toward (industrial lines)		
11. Use around home		
12. Easier than other subjects or for credit	10	1.4
13. Training in neatness and accuracy		
14. Future use (indefinite)		
B. Appeal of particular school:	(166)	(22.7)
1. Men teachers	27	3.7
2. Good teachers	45	6.2
3. Boys' school	30	4.1
4. Co-educational school		
5. Reputation of school	38	5.2
6. Attractiveness of school and equipment	23	3.1
7. School spirit	3	.4
C. Appeal of curriculum organization of school:	(85)	(11.6)
1. Get both trade and academic training		
2. More cultural opportunities		
3. Selected subject better taught here than elsewhere		
4. Variety of subjects offered		
5. Departmentalized work	18	2.4

Table 2 (Cont'd)

REASONS	Pre-Voc. Total 291	
	No.	%
6. Prepares for higher institutions..	32	4.4
7. Desire diploma of graduation.....	35	4.8
D. Outside influence:	(153)	(21.0)
1. Parent's choice.....	3	.4
2. Friends attend.....	47	6.5
3. Advised by others.....	17	2.3
4. Cheaper.....	11	1.5
5. Near home.....	20	2.8
6. Couldn't go to school of choice...	30	4.1
7. Low grades in other schools.....	25	3.4
E. Appeal of special activities:	(100)	(13.7)
1. Clubs and music.....	32	4.4
2. Sports.....	68	9.3
F. Indefinite.....	(2)	(.3)
G. Miscellaneous.....	(3)	(.4)
Totals.....	730	100

19 Ibid., p. 21

and girls prevocational schools were hereafter known as junior technical schools.

In the 72nd Annual Report submitted by Milton C. Potter, then Superintendent of Schools, trace the history of the junior technical school. He pointed out that the Instruction Committee had long hesitated to authorize such a school. Objections did not center about segregation, which was actually welcomed; but, rather as Director Charlton indicated, there was fear that these schools would eventually secure a senior high curriculum and thus be detrimental to the present technical high schools as well as failing to fulfill the purpose of the junior tech. Mr. Potter stated, "The Junior techs purpose is not so much in these early years to develop skilled craftsmanship as it is to develop interests and to aid the boy in finding types of work for which he believes he could successfully fit himself."[20]

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[20] Ibid., p. 46

In the proceedings of the school board May 7, 1935 the following statement is recorded,

> "Principal tests of junior trade school efficiency are its holding power and the development of personality controls and the promotion of mental and emotional health... An important function of the junior trade school is to furnish for an indefinite number of years a livable environment for over-age grammer school students not happy in the grades and not capable of doing or ready to do standard senior trade or high school work. The junior trade school was devised to care for, to have and to hold such students."

For the past year Arthur Will has served as Principal of Kilbourn Junior Trades School, having replaced Donald Birdsall. Using the tests previously mentioned Mr. Will is attempting to find more data with which to meet the educational problems of his school. One of his studies revealed that there is little relationship between studies taken at Kilbourn and jobs which his students secure. Shop courses are so arranged that a student will have the opportunity of learning of the nature of each field and jobs related to it. Besides woodwork and metal courses, art, printing and cement work are offered. An incentive program in the form of school awards is successfully handled. Inter and intramural athletics are an important part of the school program. These activities are carried out under conditions which are hardly conducive to good learning. The barracks which house the student body are inadequate. Shop and music activities resound through the halls. There are no locker or shower rooms. No cafeteria service is offered. Yet, in spite of limitations, constant progress is being made to better the Junior Trades School program.

CHAPTER 3

THE TEST

History of the test. The first efforts in multiple factorial analysis date back to 1930. In 1934 the first major experiment involving these techniques was performed by the Thurstones. A battery of 56 tests was given to a group of about 250 freshman students at the University of Chicago. Complete administration involved fifteen hours work with each student. Correlations were determined for each pair of tests so that in all 1600 coefficients of correlations were computed. These correlations indicated the extent to which those who succeeded in one test succeeded in another. Twelve factors were found to be sufficient to account for relations among tests.[21]

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21 Thurstone, L.L. "Theories of Intelligence" Scientific Monthly 62:101-12 February 1946

This was followed by additional studies in Chicago high schools. The purpose of these additional studies was to more closely analyze the factors previously found in an attempt to design a test which would feature the primary factors in their purest possible form. Thus, each test of the final battery would be heavily saturated with one particular factor while all other factors would be minimized. One study emphasizing the perceptual factor was given at the Lane Technical High

School, another emphasizing the inductive factor at the Hyde Park High School, while an intensive study of the memory factor was made in four high schools and a study of numerical ability was made in six high schools. All studies were in the Chicago area. These studies led to the publication of an experimental edition of tests for primary mental abilities adaptable for use with students of high school or college age. The test is now out of print.[22]

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22 Ibid., p. 106

The test used in this study is based upon the eighth grade experiment which was a continuance of the previous work done by the Thurstones. As it turned out, adapting previous tests to the fourteen year age level was the crux of the problem. In some tests little alteration was necessary while in others the entire vocabulary had to be revised. The final battery included sixty tests.

To standardize procedure and set time limits a trial form was given to several groups of children in grades 7A and 8A. Each group contained from 50 to 100 students.

Administration of tests in the main investigation took place after a training session for adjustment teachers. Fifteen schools in Chicago were selected by Miss Minnie L. Fallon, Assistant Superintendent in charge of elementary education and Dr. Grace E. Munson, Director of the Bureau

of Child Study. Besides the special training given to the adjustment teachers, written instructions to cover each days testing were given.

The 60 tests were given to 1154 8B children in eleven one hour sessions. Also available were results of the Kuhlman-Anderson tests previously given to these children. Thus in addition to the 60 tests, chronological age, mental age and sex were analyzed. Calculations made involved the calculation of 1,935 pearson correlation coefficients. Completed records indicated that 710 of the subjects had complete records for all 63 variables.

The rotated factorial matrix showed seven factors indicated in the previous experiments. These were Memory, Induction, Verbal Comprehension, Word Fluency, Number, Space, Perceptual Speed and three less easily identifiable factors. The Perceptual factor and Deductive factor are not sufficiently clear for general application.

Since the publication of this test, additional studies have resulted in publication of an additional test for five and six year olds. With this has come additional information concerning the existence and isolation of new factors or abilities.

The nature of the factors in the test. In almost every paper the Thurstones have written on the subject they have included their interpretation of the mental factors. Just

prior to the publication of their test for ages 11 to 17 Mrs. Thurstone submitted an article for publication entitled, "Primary Mental Abilities of Children."[23]

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23 Thurstone, Thelma G. "Primary Mental Abilities of Children." Educational and Psychological Measurement 1:105-16 April 1941

The introductory section of the test manual is almost a complete reproduction of this article. The quotations which follow are all from Mrs. Thurstone's paper. In addition valuable information has been taken from two other articles in periodicals.[24]

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24 Thurstone, L.L. "Testing Intelligence and Aptitudes" Hygeia 23:32-6 January 1945 and Thurstone, L.L. "Theories of Intelligence" Scientific Monthly 62: 101-12 February 1946

The instruction manual designates a prescribed order in which to test the six factors of the test. This order is followed in the discussion of the factors.

"The Number factor N is involved in the ability to do numerical calculations rapidly and accurately. It is not dependent upon the reasoning factors in problem-solving, but seems to be restricted to the simpler processes, such as addition and multiplication." Note that it is not a problem of being able to do the task but rather one of

facility in performing numerical operations. Arithmetical reasoning is far more complex. It calls for verbal thinking, number thinking, visualizing and verbal comprehension.

"The Verbal factor V is found in tests involving verbal comprehension, for example, tests of vocabulary, opposites and synonyms, completion tests, and various reading comprehension tests." A large vocabulary is characteristic of this factor. However this does not mean that an individual with a large vocabulary is necessarily fluent. The word fluency factor has been found to be quite distinct from the verbal factor. Investigations have thus far revealed the existence of three or four verbal factors but at present only these two are clearly understood.

"The Space factor S is involved in any task in which the subject manipulates an object imaginally in two or three dimensions. The ability is involved in many mechanical tasks and in the understanding of mechanical drawings. Such material cannot be used conveniently in testing situations, so we have used a large number of tasks which are psychologically similar, such as Flags, Cards, and Figures." It should be kept in mind that although the space factor is heavily involved in mechanical aptitude, it is but one of many components present in mechanical ability.

"The Word Fluency factor W is involved whenever the subject is asked to think of isolated words at a rapid rate.

It is for this reason that we have called the factor a Word Fluency factor. It can be expected in such tests as anagrams, rhyming, and producing words with a given initial letter, prefix or suffix." It has been pointed out that factorial analysis had clearly differentiated the word fluency factor from the verbal factor. One fundamental difference is that the W factor calls for the individual to produce his own words in a restricted contest whereas the V factor requires that he understand the material that is given to him.

"The Reasoning factor R is involved in tasks that require the subject to discover a rule or principle covering the material of the test. The Letter Series and Letter Grouping tests are good examples of the task. In all these experimental studies two separate Reasoning factors have been indicated. They are perhaps Induction and Deduction, but we have not succeeded in constructing pure tests of either factor. The present reasoning tests are more heavily saturated with the Inductive factor, but the factor will here be called Reasoning, R." This factor is definitely independent of the content of material so that it transcends the numerical, verbal or spatial nature of the task.

"The Memory factor M has been clearly present in all test batteries. The tests for memory which are now being used depend upon the ability to memorize quickly. It is

quite possible that the Memory factor will be broken down into more specific factors." Though current psychological textbooks claim that there is no separate memory faculty, factorial studies prove otherwise. The memory factor identified is represented best by the ability to remember paired associations. Other types of memory factors indicated seem to be related to temporal sequence as distinct from paired associations and also an ability called incidental memory which is manifested in the ability to recall past experiences without having previous intention to recall it.[25]

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25 Thurstone, L.L. "Testing intelligence and Aptitudes" Hygeia January 1945 p. 33

These, then, are the abilities measured in the test. Recent study has revealed an ability which is closely related to the Gestalt school of psychology. Both visual and auditory closure give evidence of being two additional primary mental abilities. By closure is meant the ability to get a synthesis out of a diffused presentation so that it becomes unified. Instead of perceiving unorganized parts, an individual upon presentation sees a unified whole. This sudden unification is called closure. Tests which have been constructed to measure visual closure include: (1) a task in which the subject is asked to determine which of two

figures is present in a series of more complicated figures, (2) a task in which only parts of each letter of a word is presented and the subject is required to determine the word from the incomplete pattern shown.[26]

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[26] Ibid., p. 35

It has been found, for example, that people with equal hearing ability vary in their ability to understand somewhat distorted speech. Another example is demonstrated in the variability found among individuals learning telegraphic code.

The authors of the test admit the presence of several abilities which they have not been able to isolate. Thus in using the test it must be kept in mind that one does not obtain a complete picture of an individual's intelligence. However, regardless of the shortcomings of the test as it is now compiled it is still a better interpretation of an individuals intelligence than the single index of the many intelligence tests of today.[27]

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[27] For a complete copy of the test see Appendix A

Organization and standardization of the test. During the 1940-41 school year 25,000 copies of the test were printed. These were administered to 18,000 Chicago Public

School children in grades 5B on up through the senior year in high school with approximately 1,000 at each half year level. This was done in order to secure age norms throughout the entire range of abilities found among eighth grade children since the test was to become a part of the testing program for 8B children in all Chicago schools. Besides the norms prepared, a single index can be obtained by securing a weighted average of the six ability scores.

The battery is composed of 17 tests, three for each of the factors except Memory which has two. Each factor requires approximately 40 minutes to be tested. This permits testing within a regular class period. The test should be administered on six successive school days. The order of sessions are as follows:

first day.....	N	fourth day.....	W
second day.....	V	fifth day.....	R
third day	S	sixth day	M

Each testing period consists of both practice tests and the tests proper. In all factors except W a supplementary yellow practice booklet is provided. In the W factor one booklet is provided for both practice and test problems. Practice sessions have approximate time limits while the test proper has exact time limits.

Scoring can be accomplished by hand stencils or by scoring machine for all factors except the W factor. However, hand scoring for this factor is comparatively fast.

Best use of the test is made through an individual profile which is easily constructed for each student. In this way the observer can tell at one glance just how well the student does in any particular factor and also how he compares with himself in the various factors. Below are four cases illustrated by profile (Fig. 1). With each is the particular field in which the students were interested. Mr. Thurstone points out that these particularly high rankings in certain abilities go hand in hand with the interests shown.

The method of evaluating the performance of a student has been greatly simplified through the inclusion of numerous tables. To determine an individual's rank, the composite score must be found first. This score is nothing more than the sum of the scores received on the test for each particular factor. Norms are listed in tables according to chronological age level, starting at ten years of age and going to eighteen with divisions at every six month interval. Thus, by checking an individual's composite score for a particular factor against his age the percentile rank can be determined for that score via the table. Thus, an individual with a composite score of 65 for the Number factor who is between 14 and 14½ would rank at the 23rd percentile for this factor. It is recommended that the evaluate should not split hairs over ranking since the table is "rough" and visual interpolation is usually close enough.

28

TABLE 3

THE TEST BATTERY

Factor	Tests	Time Limits: Practice	Time Limits: Test	Scoring Formula	Maximum Score	Minimum Score
N Number	Addition Multiplication Three-Higher	3	6	R-W	70	0
V Verbal Meaning	Sentences	3	5	R	40	0
	Vocabulary	3	4	R	50	0
	Completion	3	6	R	45	0
S Space	Flags	10	5	R-W	60	0
	Figures	6	5	R-W	54	0
	Cards	6	5	R-W	54	0
W Words Fluency	First Letters	3	5	R	None	0
	Four-Letter Words	3	4	R	None	0
	Suffixes	3	4	R	None	0
R Reasoning	Letter Series	6	6	R	30	0
	Letter Grouping	7	4	R	30	0
	Pedigrees	5	6	R	40	0
M Memory	First Names	1-2[1]	5-8[1]	R	20	0
	Word-Number	1-2[1]	4-8[1]	R	16	0

[1]The first number is the time for presentation of the memory material. The second is the time for recall.

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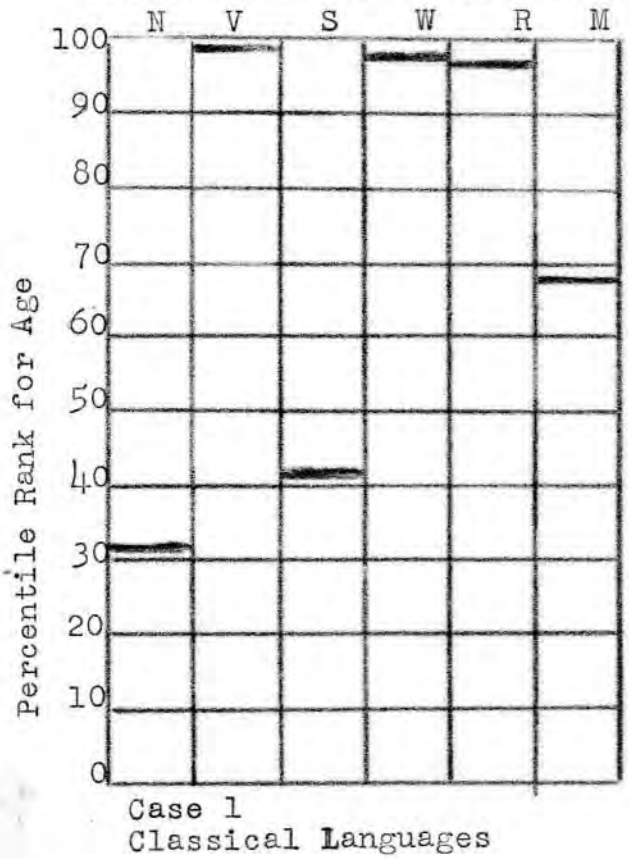
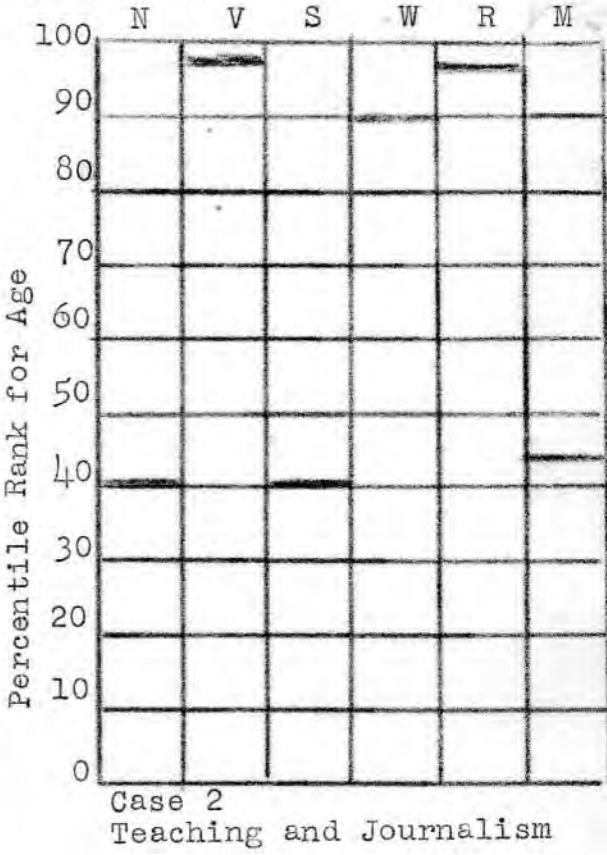
[28]Thurstone, L.L. and Thurstone, T.G. Manual for Scoring and Interpretation of The Chicago Tests of Primary Mental Abilities for Ages 11 to 17. Washington, D.C. American Council on Education p. 8

FIGURE 1[29]

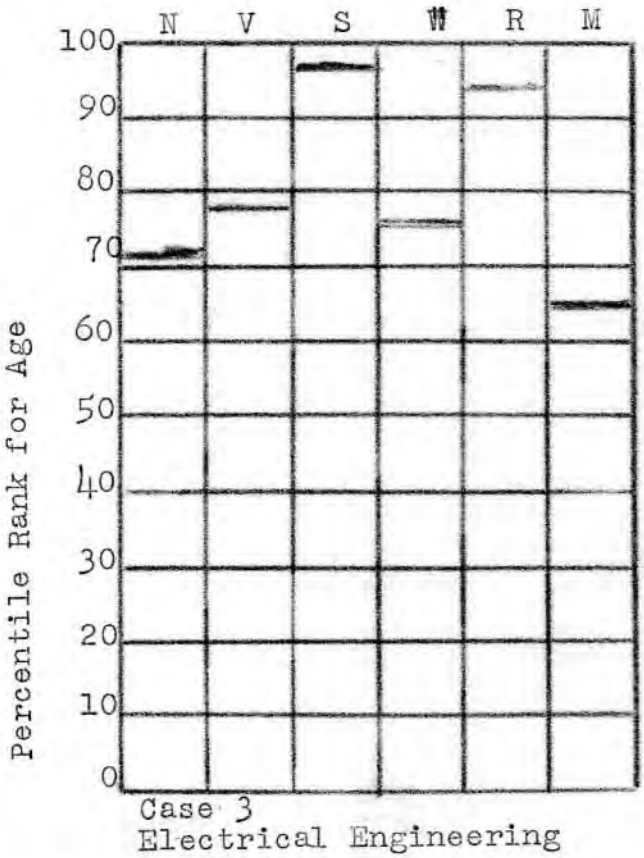
RELATIONSHIP OF P.M.A. PROFILE TO INTERESTS



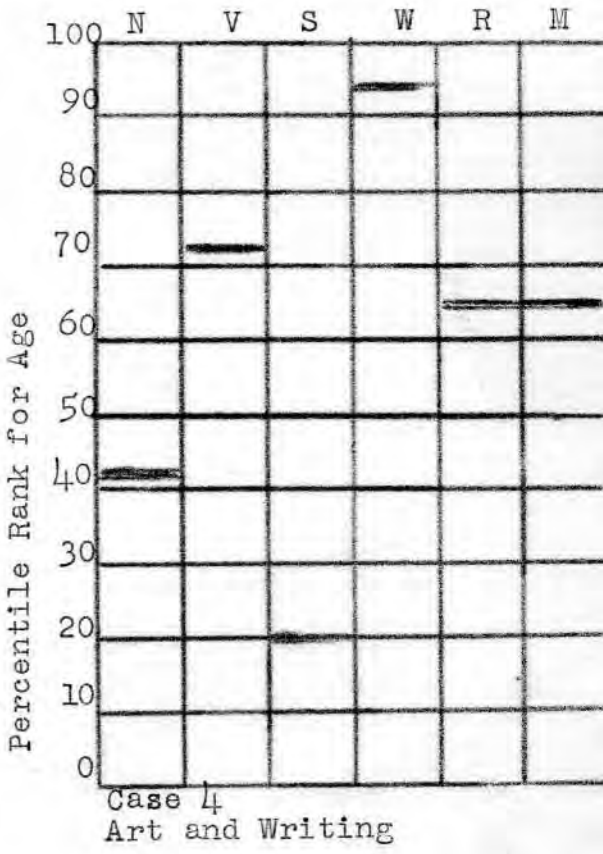
Case 1
Classical Languages



Case 2
Teaching and Journalism



Case 3
Electrical Engineering



Case 4
Art and Writing

[29] Ibid., p. 32

For those who wish to determine the age for which a particular score is at par, the authors have included an age equivalents table for age groups in three month intervals and for each of the six composite scores.

Reliabilities and intercorrelations. Reliabilities of the six composites in the test battery were computed by the split-half method. Approximately 200 students at each half grade level from the sixth through the twelfth were used as subjects. Odd even correlations were computed and then reliabilities were estimated by the Spearman-Brown correction for double length. Results are summarized in the following table. Higher reliability coefficients would have been obtained if the calculations had been made for a range of ability greater than found in one year. Note that no reliabilities are available for the Word Fluency tests. The nature of the tests does not permit reliabilities to be found by the split-half method. Reliabilities were not found by the re-test method on comparable tests. Also note that reliabilities of the Memory factor are considerably lower than the reliabilities of the other composites.

Also computed were reliabilities of the individual tests. These were determined by the split-half method for the 10B group of students. The table below lists the findings (Table 5).

In table six are listed the validites of the composite tests. This table shows the estimated correlation of the

six composite scores with each of the primary mental abilities.

TABLE 4[30]

RELIABILITIES FOR COMPOSITES

	N	V	S	R	M
6B	.96	.95	.96	.96	.63
6A	.97	.96	.96	.96	.64
6	.97	.95	.96	.96	.63
8B	.96	.96	.97	.97	.68
8A	.97	.97	.97	.97	.65
8	.97	.96	.97	.97	.67
10B	.96	.96	.97	.97	.78
10A	.97	.97	.98	.97	.68
10	.97	.96	.98	.97	.74
12B	.98	.97	.98	.97	.82
12A	.98	.96	.98	.97	.82
12	.98	.96	.98	.97	.82

TABLE 5[31]

INDIVIDUAL TEST RELIABILITIES

Test	Reliability	Test	Reliability
First Names	.71	Cards	.91
Word-Number	.80		
		Addition	.89
Sentences	.92	Multiplication	.94
Vocabulary	.94	Three-Higher	.95
Completion	.72		
		Letter Series	.91
Flags	.96	Pedigrees	.97
Figures	.96	Letter Grouping	.88

30 Ibid., p. 29
31 Ibid., p. 31

TABLE 6[32]

VALIDITIES

	Primary Abilities					
	N	W	V	S	M	R
Composite Score N	.90	.44	.39	.33	.21	.57
Composite Score W	.43	.91	.54	.20	.39	.47
Composite Score V	.41	.52	.97	.19	.38	.58
Composite Score S	.22	.15	.15	.92	.13	.34
Composite Score M	.31	.37	.36	.14	.79	.41
Composite Score R	.52	.51	.57	.34	.38	.90

[32]Ibid., p. 30

By following the diagonal cells of the table it will be noted that highest correlations occur between the composite score of a factor and the factor itself. Thus the Number composite score has a higher correlation with the Number ability than with any of the other abilities.

Table seven presents for inspection the intercorrelations of composite scores. Highest intercorrelations occur between the Verbal meaning and Word Fluency and between the Verbal factor and Reasoning. In general there does not exist a high intercorrelation between composite scores.

TABLE 7[33]

INTERCORRELATIONS OF COMPOSITES

	N	W	V	S	M	R
N	...					
W	.41	...				
V	.40	.54	...			
S	.28	.17	.16	...		
M	.31	.36	.35	.13	...	
R	.53	.49	.59	.29	.39	...

[33] Ibid., p. 29

CHAPTER IV

THE PROCEDURE OF THE STUDY

Method of selection of subjects. At the Kilbourn Junior Trades school a card index is kept of test results obtained while in attendance. This is in addition to the personal folder which holds the complete history of each student. Twice a year the California Test of Mental Maturity and the Progressive Achievement Tests are administered under the supervision of the vice principal. Thus every student is classified according to his mental capacity and academic achievement. These results are used as the basis for grade placement.

From the records a tentative list of possible subjects was made. Sixty three names out of approximately three hundred were included. From this "rough" list came the final subjects. The weeding out process involved conferences with the principal and faculty, a review of test records and a study of each individual's folder.

The primary criterion for selection of subjects difference between (1) language and non-language intelligence and (2) difference between reading age and mental age. However, in two cases in which differences weren't exceptionally large the subjects were selected because additional data justified such selection. Included in this additional data

were differences as reported by teachers, previous academic records and the recommendation of the principal who was familiar with these subjects. When the total group was sub-divided however, these students who did not demonstrate great difference were excluded. Thus in studying specific groups only clearly differentiated cases were selected. An analysis of the records of the subjects on following pages will support the selection of subjects.

To facilitate subdivision into groups and analysis at a glance, a card was made out containing pertinent data. An example of such a card appears below. Colored pencils

FIGURE 2
SUBJECT RECORD CARD

Name _____ C.A._____M.A._____

Intelligence _____

Non. Lang. _____

Language _____

Diff. _____

Reading _____

Vocab. _____

R.A. _____

Diff. (MA-RA)_____

PRIMARY MENTAL ABILITIES

	N	V	S	W	R	M
Raw Compos.						
Centile Rank						

were used to designate the direction of the difference.

Administration of the test. The test was administered in accordance with instructions. The pretest group was composed of fourteen students. The main test group was composed

of twenty students although one dropped out after the second test session and the results of two others were disallowed for reasons previously mentioned. Because of the shortage of space in the school and the moving about of classes to permit use of visual aids, no one room was used. Thus, there was some difficulty in getting the group together. However, this delay was cut to a minimum after the first two sessions.

Before the testing sessions it was explained to the group that the purpose of the test was to get more information about pupils attending the school so that a curriculum more to their liking and to their benefit could be established. The group was informed that in doing their best since they would be helping themselves and their classmates. Though the results have not as yet been used for guidance purposes, students who were particularly interested did find time to come to the office and talk about the test.

Each testing session should last approximately forty minutes. Since practice periods are not timed exactly, it was possible to run overtime. The groups tested were hetrogeneous as to intellectual makeup. Therefore it was necessary to spend much time explaining to the slower students the technique involved in every test. A few had the habit of saying they understood the task when actually they didn't. This required close observation during the practice sessions

so that individual attention could be given. This was in accord with test directions. As a result of this, testing periods usually ran longer than the prescribed time.

The test was administered to two separate groups. This would have required twelve testing sessions. However, the students attending Kilbourn have a reputation for missing school. Thus, for practically every test session one to five subjects were absent. This meant that instead of twelve sessions there were twenty-two. Using the long form of the test meant that with all the absences many extra hours of testing time were consumed.

Testing rapport in general was good. Once the students got into a test they found it interesting. Only one situation required special attention. One of the boys who appeared to have been the victim of excessive testing programs reacted unfavorably. During the final testing session he decided that he was tired of testing. He failed to work to capacity during this session. After a friendly talk between the boy and the principal, the test was taken again. Fortunately, this reaction occurred during the testing of the Memory factor. Thus in the retest given to him past experience was of no value. Since the Memory factor is the last tested, there was no danger of future tests being influenced by a recurrence of this indifference. On the other hand, other subjects showed real interest and enthusiasm and delighted in taking the tests.

Scoring was done by hand with the use of stencils provided. All scoring was double checked. The Word Fluency factor cannot be scored by machine or stencil; however, it can be scored quite rapidly by hand alone.

The pretest group. The purpose of working with a pretest group was to first determine whether there was any basis for such a study. Rather than break into a study of special groups without any indication as to whether it would bear any fruit, a pretesting program was planned. If a pretest group, selected at random from the list previously compiled, showed any important difference in primary mental abilities, then further study was justified. A difference could be called important if the difference between means of the primary mental abilities were significant. A difference between two mental abilities could be called significant if it met the requirements set by Fisher.[34]

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[34] Fisher, R.A. Statistical Methods for Research Workers 6th Edinburgh: Oliver & Boyd 1936, p. 139

Fisher has suggested that limits (which he calls fiducial limits) on the measuring scale be established which include the middle 95 per cent on the middle 99 per cent of the values. If a sample mean falls outside the 95 per cent limit it is said to deviate "significantly" from the true mean. If a sample mean falls outside the 99 per cent limit it is said to deviate "very significantly". Thus a

"significant" deviation from the true mean is one that occurs only once in 20 times and a "very significant" deviation is one that occurs once in 100 times.

The members of the pretest group ranged in C.A. from 13-3 to 16-6 and in M.A. from 10-11 to 15-3. Table 8 gives the pertinent data. Of the group, six are superior in language intelligence while eight are superior in non language. Among the six, differences or superiority range from two I.Q. points to twenty six. However, it should be noted that after the two point difference the next greatest difference is eighteen I.Q. points. The mean language superiority is 18.33.

Among those who are superior in their non language intelligence, differences range from three to thirty two I.Q. points, the mean difference being 19.50.

In reading, only four read above their mental age. However, the mean difference between their mental age and reading age is eighteen months. For the other ten subjects, differences, inferiority from two months to thirty eight months. It is expected that students with a low I.Q. will be inferior readers. We can consider an individual of this group who is reading within six months of his capacity as being rather successful. Note that there are three of the ten who fall into this category. The mean difference of this group is 14.7 months.

TABLE 8

THE PRETEST GROUP

Subject	Non-Lang. I.Q.	Lang. I.Q.	Diff. in I.Q. Points*	Reading Age	Mental Age	Months Diff.*
AR	87	105	18	14-4	14-7	3
AW	73	75	2	10-4	11-10	18
DT	82	66	16	10-3	11-10	19
EM	73	70	3	10-9	10-11	2
GF	94	75	19	12-1	11-4	9
GR	96	81	15	11-4	12-8	16
HJ	128	102	26	12-1	15-3	38
KT	97	77	20	11-2	12-7	17
KD	105	73	32	11-4	12-4	12
LJ	111	81	30	12-2	13-6	16
PA	61	82	21	13-2	10-9	29
RR	75	98	23	13-7	11-9	22
RM	83	68	15	11-4	11-10	6
VJ	67	93	26	13-3	12-3	12

*Differences are given in absolute numbers. It can readily be seen by inspection which phase of measurement the subject was superior in.

It might be expected that those who are inferior in their language I.Q. would be inferior readers. This is generally true. Only three of the fourteen deviated from

_____ Examiner_____ Date_____ RECORD SHEET No._____

Pedigrees	MEMORY: First Names	MEMORY: Word-Number	Composite Scores on Primary Abilities: N	V	S	W	R	M	Percentile Ranks on Composite Scores: N	V	S	W	R	M
6	9	1	81	79	68	52	58	10	31	47	41	27	60	24
8	2	0	105	21	83	35	13	2	49	01	52	03	11	01
1	10	1	54	32	131	28	51	11	06	01	89	01	34	26
7	9	1	72	23	21	20	51	10	16	01	03	03	39	20
2	12	1	58	51	86	32	41	13	10	15	67	06	30	48
7	5	3	111	40	65	46	34	8	70	10	43	27	23	15
2	9	3	97	61	91	51	54	12	63	33	75	38	64	47
7	6	2	25	48	49	34	37	8	01	12	22	05	19	15
9	8	0	78	23	95	20	24	8	31	01	75	01	16	15
5	9	4	88	34	126	37	62	13	39	02	91	04	65	43
2	3	3	73	60	64	54	32	6	23	18	35	27	12	05
9	5	3	40	52	4	62	33	8	06	24	01	07	14	18
5	6	3	81	32	68	31	27	9	21	01	34	01	06	15
3	8	0	87	55	101	46	40	8	37	14	76	13	22	12
							Median		27	11	47.5	5.5	22.5	16.5

THE CHICAGO TESTS OF PRIMARY MENTAL ABILITIES
THE AMERICAN COUNCIL ON EDUCATION

School _____

	NAME	Sex	Age Yr	Age Mo	NUMBER Addition	NUMBER Multiplication	NUMBER Three-Higher	VERBAL Sentences	VERBAL Vocabulary	VERBAL Completion	SPACE Flags	SPACE Figures	SPACE Cards	W
1	AR				16	30	35	22	26	31	22	25	21	3
2	AW				14	53	38	6	6	9	28	40	15	2
3	DT				8	12	34	5	6	21	43	53	35	2
4	EM				23	49	0	8	4	11	3	10	8	1
5	GF				12	12	34	13	12	26	31	27	28	2
6	GR				21	43	47	12	10	18	17	26	22	3
7	HJ				13	35	49	11	20	30	38	31	22	3
8	KT				13	12	0	13	15	20	19	18	12	2
9	KD				11	31	36	6	3	14	41	28	26	1
10	LJ				8	33	47	6	10	18	36	44	46	1
11	PA				14	27	32	15	24	21	24	26	14	4
12	RR				7	4	29	15	17	20	Guessed 2	0	2	3
13	RM				15	24	42	6	7	19	24	25	19	2
14	VJ				11	32	44	10	18	27	36	39	26	3
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														

this pattern. Those who were poorest in language I.Q. (as compared with non language I.Q.) were usually among the poorest readers (as compared with M.A.)

In table nine is a summary of the pretest group's record. Composite scores are obtained by adding the scores of the tests in each factor. Percentile ranks on composite scores are obtained from tables of norms listed in the test manual.

In comparing groups with those tested by the Thurstones, the medians rather than the means have been computed. The reason for this lies in the fact that norms are represented in percentiles. It is known that all percentile units are not equidistance apart. Guilford[35] states that medians are to be computed in preference to means when "there is uncertainty about the equality of the unit of measurement."

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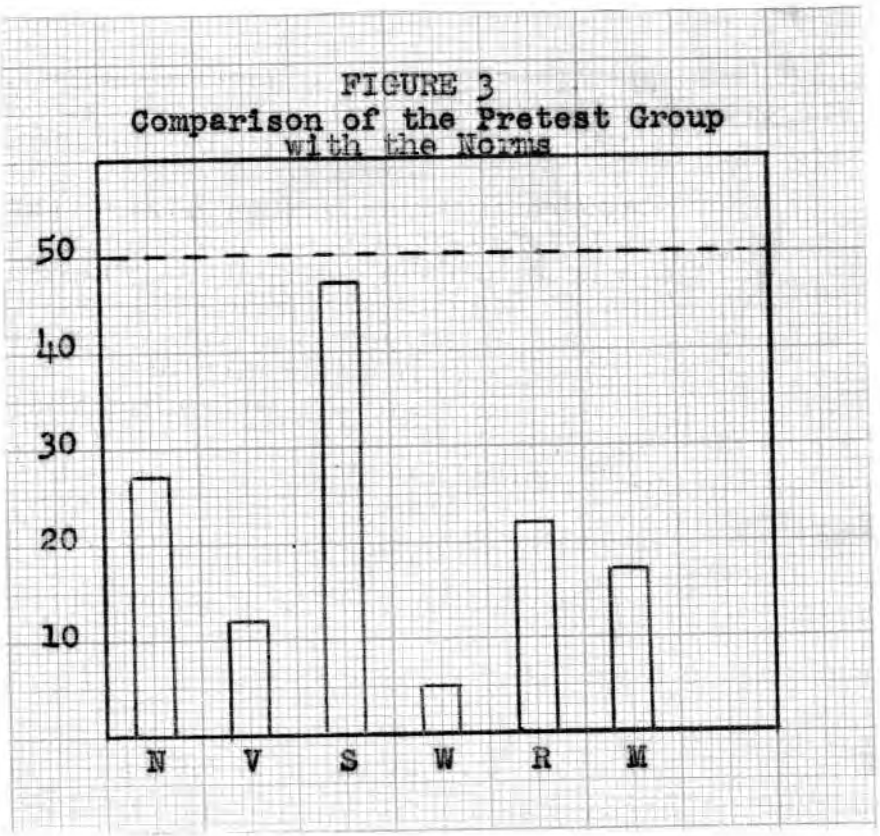
35 Guilford, J.P. Fundamental Statistics in Psychology and Education New York: McGraw Hill Book Co., Inc. 1942 p. 44

In figure three the medians are graphed. Care should be taken in interpreting the medians. We can expect the median of the groups which the Thurstones tested to fall at the 50th percentile. The graph tells us how the pretest group compares with the norms for each factor. It is obvious also that with such a small group it is dangerous to put too much weight upon the importance of these medians.

FIGURE 3
Comparison of the Pretest Group with the Norms



The primary purpose of the pretest group was to determine if there was any significant difference between any two of the factors. A significant difference would indicate that further study was justified. The statistical technique employed is excellently described by Guilford.[36]

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[36] Ibid., p. 137-42

In computing significance, if a correlation factor is involved it can be handled in two ways. First, the correlation can be applied in the formula to determine the standard error of a difference between means or the individuals may

be paired and thus automatically account for the correlation. Whenever it is possible to pair subjects or measurements for statistical purposes, Guilford recommends that it be done, provided of course, that the pairings are done on some significant basis.

In the pretest group each individual is paired with himself, and his abilities in two different factors are compared. When pairing does not take place, the standard error of the mean must first be computed for each group or factor by the formula below in which M is the standard error of the mean of each group measurement. σ is the standard

(1) $$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

deviation for each group or factor and N is the number of subjects.[37]

[37] Ibid., p. 128

From this, the standard error of the difference between means may be obtained through the following formula:

(2) $$\sigma_{d_M} = \sqrt{\sigma^2_{M_1} + \sigma^2_{M_2}}$$

where σ_{d_M} is the standard error of the difference between means, σ_{M_1} is the standard error of the mean of the first factor and σ_{M_2} is the standard error of the mean of the second factor. Formula (2) assumes no correlation between factors exists.[38]

[38] Ibid., p. 135

However the standard error of the mean can be computed directly from the raw data through the following process:

(1) When working with two different scales of measurement a common scale must first be found. Using percentile rank scores is inadequate since the units are unequal. Composite scores (the total score for all tests measuring a particular factor) were used after the scales were equalized. The equalization process involved nothing more than simple arithmetic computation. If the first test were to have a perfect composite score five and the second test a perfect composite score of ten, it would be necessary to multiply each score in the first test by two (the quotient of 10 ÷ 5) to equalize the two scales. Thus, in the case of the Memory and Reasoning factors used in the pretest the following computation was carried out:

$$\frac{\text{Highest Possible score for R}}{\text{Highest Possible score for M}} = \frac{100}{36} = 2.77 \quad \text{then:} \quad 2.77 \times \text{M (col. 2 Table 10)}$$

Thus to make every composite score for the Memory factor carry proper weight when compared with the Reasoning factor each composite score was multiplied by 2.77 as shown in column two of Table 10.

(2) Instead of computing the standard deviation for each factor, the paired scores were subtracted algebraically and a mean of the differences was immediately obtained, as is shown at the bottom of column four of Table 10.

(3) The standard deviation of these differences is next obtained. Each difference between factors is subtracted algebraically from the mean of the differences to obtain "x" the deviation from the mean of the differences (column five). Each deviation is then squared; the group is totalled and divided by the number of subjects and the standard error is obtained. Note that this is nothing more than carrying out the formula for the standard deviations only here we are working with differences between two factors and the means so obtained.

(4) By calculating the standard error of the mean of these differences as shown in formula one, page 47, the standard error of the differences of the means is obtained directly. Thus in all calculations, what we call the sigma of the mean is actually the sigma of the difference of the means determined by working with differences. This is to be noted in studying the calculations in the appendix.

(5) The t score is obtained by dividing the differences between the means by the standard error between means (column seven). The level of confidence can then be obtained directly from a table. Many authors list only the t values required for the five and one per cent level of confidence.[39]

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[39] Ibid., p. 135-142. A typical problem is excellently explained here.

TABLE 10

COMPUTATION OF THE SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS FOR THE MEMORY AND REASONING FACTORS — PRETEST GROUP

	(1) Memory	(2) Mx2.77	(3) Reasoning	(4)	(5)	(6)
	M	M	R	$R-M^1$	X	X^2
AR	10	28	58	+ 30	16.57	274.56
AW	2	6	13	+ 7	6.43	41.34
DT	11	30	51	+ 21	7.57	57.30
EM	10	28	51	+ 23	9.57	91.58
GF	13	36	41	+ 5	8.43	71.06
GR	8	22	34	+ 12	1.43	2.04
HJ	12	33	34	+ 1	12.43	154.50
KT	8	22	37	+ 15	1.57	2.46
KD	8	22	24	+ 2	11.43	130.64
LJ	13	36	62	+ 26	12.57	158.00
PA	6	17	32	+ 15	1.57	2.46
RR	8	22	33	+ 11	2.43	5.90
RM	9	25	27	+ 2	11.43	130.64
VJ	8	22	40	+ 18	4.57	20.88
				E =188		
				M =13.43		E =1143.36
						N =81.67
						σ =9.04

$$\sigma_M = \frac{M}{N-1}$$

$$= \frac{9.04}{14-1}$$

$$= \frac{9.04}{3.61}$$

$$\sigma_M = 2.50$$

$$t = \frac{M - M_2}{M}$$

$$= \frac{13.43}{2.50}$$

$$t = 5.37$$

significant at th 1% level

Garrett,[40] among others, lists t scores for the one, two,

[40] Garrett, H.E. Statistics in Psychology and Education, 3rd edition, New York: Longmans 1947 p. 137

five, ten and fifty per cent levels of confidence. To avoid misinterpretation, it cannot be too strongly emphasized at this point that only t values at the one, two, or five per cent level of confidence indicate significance. Other t scores at the ten or fifty per cent level of confidence are mentioned only to indicate the relative "distance" from significance.[41]

[41] This procedure was suggested by Dr. L. R. Kennedy

In the pretest group a critical ratio of 5.37 was obtained. By looking under the proper degrees of freedom column, (when two sets of measurements are correlated, the number of degrees of freedom is the number of pairs minus two) in this case twelve, it can be found that a critical ratio of 3.06 is necessary for the findings to be significant at the one per cent level. Thus it can be concluded that the pretest group is significantly superior in their Reasoning ability as compared with their Memory ability. This finding was the basis for a more extensive study.

The total group. As previously mentioned, an additional twenty students were tested. However two had their records

discounted because of inferior reading ability and a third failed to complete the testing program. This left a total of thirty one students including those who were in the pretest group. Table eleven summarizes the differences found in members of the total group.

Of the 31, thirteen were superior in their language I.Q. while eighteen were superior in their non language I.Q. The range among those students who were superior in their language I.Q. extended from two to twenty seven I.Q. points with a mean superiority of 17.15 I.Q. points. Those superior in non language I.Q. ranged from two to thirty two I. Q. points in their superiority, the mean being 14.05 I.Q. points. Figure four gives the distribution of those who were superior in language I.Q. while figure five shows the distribution of those who were superior in non language I. Q. Note that for such small groups the distributions are fairly well distributed. Thus in studying the total group a good cross section of the student population is represented. In studying those individuals who were representative of students superior in language I. Q. or when comparing one group with another, as is done in another part of the study, those individuals who demonstrated less than 14 I. Q. points superiority were dropped. However, it is preferable to have the total group more representative of the school population.

TABLE 11

THE TOTAL GROUP

Subject	Non Lang. I.Q.	Lang. I.Q.	Diff. in I.Q.Points*	Reading Age	Mental Age	Months Diff.*
AZ	82	96	14	12-8	12-8	0
AH	88	83	5	11-7	11-11	4
AR	87	105	18	14-4	14-7	3
AW	73	75	2	10-4	11-10	18
BG	48	75	27	11-9	9-2	31
BF	80	76	4	12-0	11-5	7
BH	76	93	17	12-5	12-7	2
BHa	78	60	18	9-0	11-0	24
DT	82	66	16	10-3	11-10	19
EM	73	70	3	10-9	10-11	2
GE	54	80	26	12-7	10-2	29
GF	94	75	19	12-1	11-4	9
GR	96	81	15	11-4	12-8	16
HJ	128	102	26	12-1	15-3	38
HE	83	78	5	9-2	11-2	12
HH	103	96	7	12-5	13-9	16
HL	66	75	9	9-1	10-0	11
KT	97	77	20	11-2	12-7	17
KD	105	73	32	11-4	12-4	12
LJ	111	81	30	12-2	13-6	16
LW	103	90	13	12-8	13-7	11
MW	84	82	2	14-3	12-4	23
NA	77	68	9	13-5	11-5	24
NG	73	89	16	12-2	12-4	2
PG	86	72	14	12-9	12-5	4
PA	61	82	21	13-2	10-9	29
RR	75	98	23	13-7	11-9	22
RM	83	68	15	11-4	11-10	6
SG	82	86	4	13-5	12-6	11
VJ	67	93	26	13-3	12-3	12
ZR	96	76	20	10-1	12-2	25

* Differences are given in absolute numbers. It can readily be seen by inspection which phase of measurement the subject was superior in.

FIGURE 4

DISTRIBUTION OF STUDENTS SUPERIOR IN LANGUAGE I. Q.

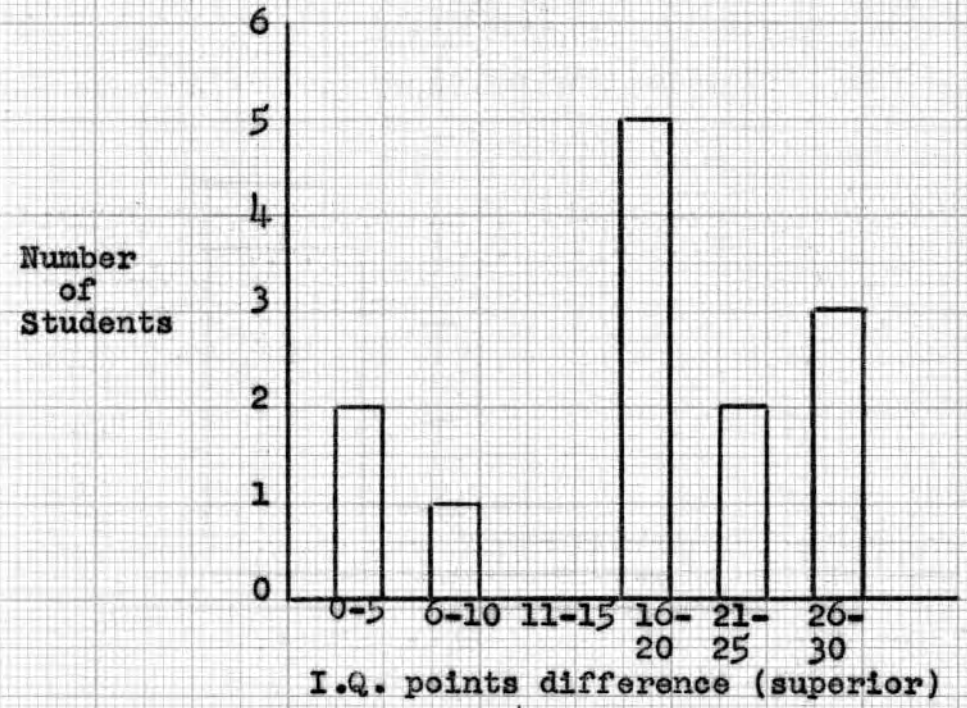
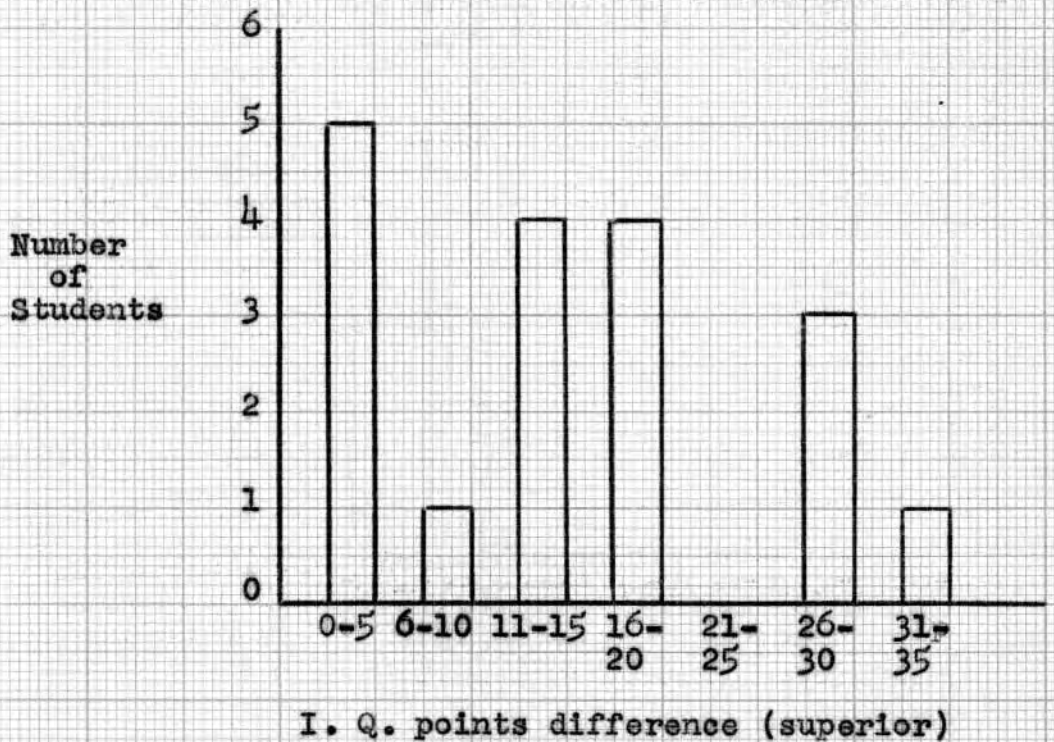


FIGURE 5

DISTRIBUTION OF STUDENTS SUPERIOR IN NON-LANGUAGE I. Q.



While there is no real evidence to indicate that the total group is representative of the school population, one can surmise that a wider distribution is more similar than a group which includes only the extremes, that is, those who are greatly superior in language or non language I. Q.

In classifying students according to reading ability, a comparison was made between reading age and mental age. Among the thirty one, eleven had a reading age which was twelve months or more below their mental age; eight were between one and eleven months superior in reading ability while seven individuals fell in the category of readers twelve or more months above mental age. A more detailed description can be found in table twelve. Note that those reading above their mental age have been called superior readers and those reading below have been called inferior readers. In this situation the terms have been used only to make a distinction between those reading below and above their mental age. In a later part of the study these separate groups are dealt with. Inferior readers are classified there as individuals who are retarded one year or more. The other group concerns itself with average or above average readers and includes individuals who read four or more months better than their mental age.

Table thirteen contains a summary of the test results

TABLE 12

DISTRIBUTION OF GROUP - INDICATING DIFFERENCES BETWEEN MENTAL AGE AND READING AGE

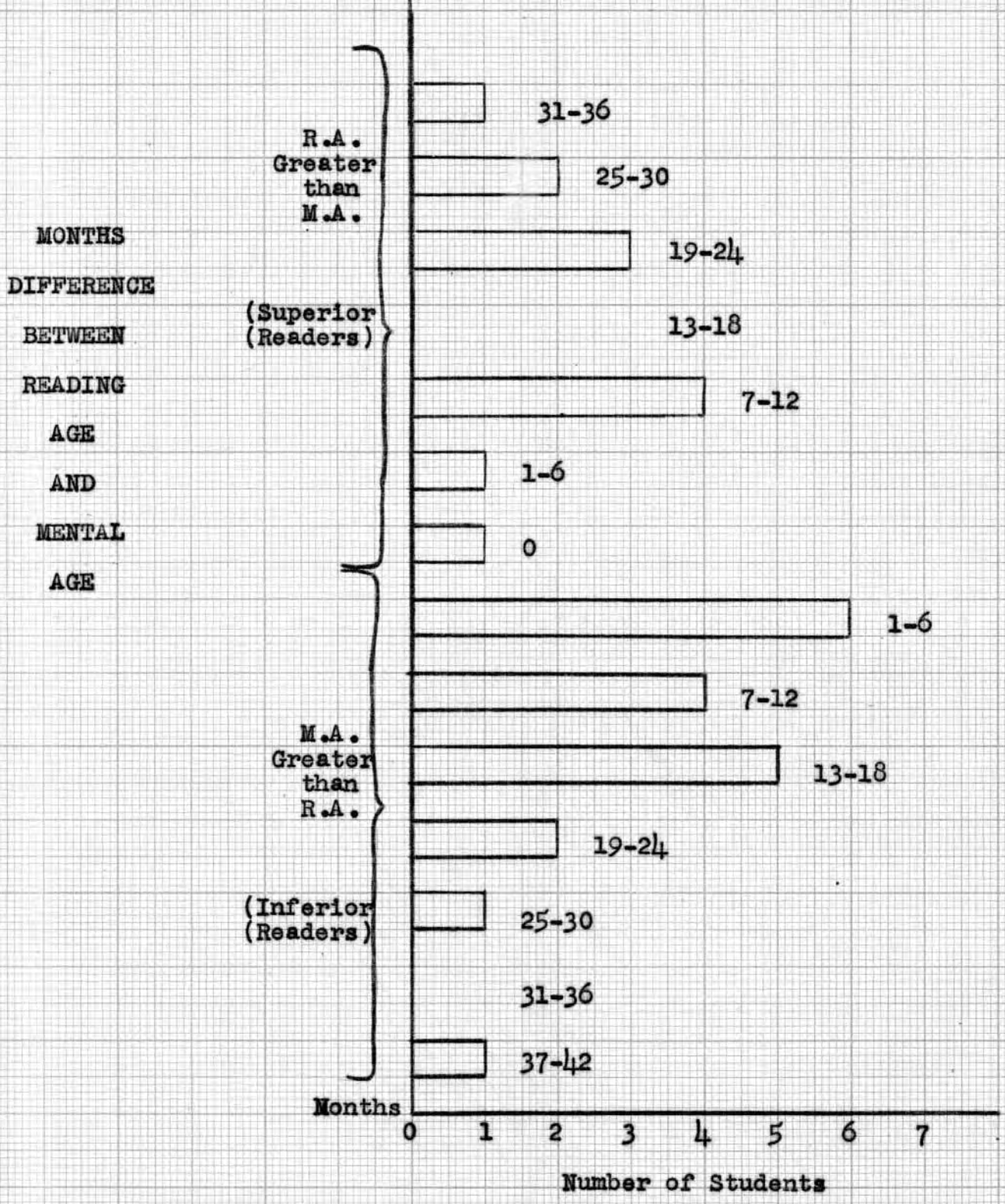


TABLE 13

THE CHICAGO TESTS OF PRIMARY MENTAL ABILITIES
THE AMERICAN COUNCIL ON EDUCATION

School_____ Grade_____ Room_____ Examiner_____ Date_____ RECORD SHEET No.

NAME	Sex	Age Yr	Age Mo	NUMBER: Addition	NUMBER: Multiplication	NUMBER: Three-Higher	VERBAL: Sentences	VERBAL: Vocabulary	VERBAL: Completion	SPACE: Flags	SPACE: Figures	SPACE: Cards	WORD FLUENCY: First Letters	WORD FLUENCY: Four-Letter Words	WORD FLUENCY: Suffixes	REASONING: Letter Series	REASONING: Letter Grouping	REASONING: Pedigrees	MEMORY: First Names	MEMORY: Word-Number	Composite Scores on Primary Abilities: N	V	S	W	R	M	Percentile Ranks on Composite Scores: N	V	S	W	R
[illegible]				[illegible]	[illegible]	[illegible]	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5	5	13	9	10	10	2	87	45	66	38	38	12	40	06	37	11	25
[illegible]				0	3	0	12	11	14	33	2	0	13	9	0	15	10	16	3	0	3	37	35	22	41	3	0	03	11	01	29
[illegible]				16	30	35	22	26	31	22	25	21	35	11	6	15	17	26	9	1	81	79	68	52	58	10	31	47	41	27	60
[illegible]				14	53	38	6	6	9	28	40	15	23	7	3	1	4	8	2	0	105	21	83	35	13	2	49	01	52	03	11
[illegible]				11	22	28	11	5	16	0	0	0	24	8	11	6	3	3	5	0	61	32	0	43	12	5	10	02	00	10	00
[illegible]				7	37	39	6	12	15	6	0	1	27	2	8	9	13	12	7	0	83	33	7	37	34	7	36	04	02	08	19
[illegible]				15	28	70	8	16	22	34	24	25	20	10	0	9	6	15	9	1	103	46	83	35	30	10	61	11	63	08	14
[illegible]				7	0	14	1	4	4	20	24	27	25	9	1	12	3	6	3	2	81	9	71	35	21	5	33	00	48	08	06
[illegible]				8	12	34	5	6	21	43	53	35	20	4	4	10	20	21	10	1	54	32	131	28	51	11	06	01	89	01	34
[illegible]				23	49	0	8	4	11	3	10	8	15	3	2	12	12	27	9	1	72	23	21	20	51	10	16	01	03	03	39
[illegible]				18	30	29	14	19	32	26	18	24	28	5	11	9	10	13	8	3	77	65	68	44	32	11	20	20	34	09	11
[illegible]				12	12	34	13	12	26	31	27	28	26	5	1	12	7	22	12	1	58	51	86	32	41	13	10	15	67	06	30
[illegible]				21	43	47	12	10	18	17	26	22	35	8	3	5	12	17	5	3	111	40	65	46	34	8	70	10	43	27	23
[illegible]				13	35	49	11	20	30	38	31	22	34	11	6	22	10	22	9	3	97	61	91	51	54	12	63	33	75	38	64
[illegible]				27	16	32	6	8	6	46	50	47	9	0	0	14	7	14	9	1	75	20	143	9	35	10	26	01	99	00	20
[illegible]				23	38	58	16	23	28	28	29	27	37	14	11	11	7	24	9	5	119	67	84	62	42	14	77	32	64	52	33
[illegible]				0	22	17	4	3	13	14	19	14	13	7	0	10	10	5	1	4	39	20	47	20	25	5	03	01	18	50	06
[illegible]				13	12	0	13	15	20	19	18	12	25	6	3	11	9	17	6	2	25	48	49	34	37	8	01	12	22	05	19
[illegible]				11	31	36	6	3	14	41	28	26	11	4	5	5	10	9	8	0	78	23	95	20	24	8	31	01	75	01	06
[illegible]				8	33	47	6	10	18	36	44	46	19	13	5	19	18	25	9	4	88	34	126	37	62	13	39	02	91	04	65
[illegible]				8	10	29	9	16	22	24	26	19	22	4	5	11	[illegible]	22	6	0	47	47	69	31	45	6	05	08	44	04	30
[illegible]				12	29	30	13	19	24	21	28	12	31	5	10	7	7	14	11	3	79	56	61	46	28	14	30	16	31	13	08
[illegible]				7	8	0	8	25	24	40	41	48	34	11	8	7	10	15	7	1	15	57	129	53	83	8	00	07	89	14	08
[illegible]				0	0	12	18	28	27	26	25	25	50	10	10	16	5	14	8	1	12	73	76	70	31	9	00	33	49	58	16
[illegible]				12	25	46	15	13	23	19	17	16	23	9	5	16	11	23	15	2	83	51	52	37	50	17	24	08	20	03	36

THE CHICAGO TESTS OF PRIMARY MENTAL ABILITIES
THE AMERICAN COUNCIL ON EDUCATION

School_____ Grade_____ Room_____ Examiner_____ Date_____ RECORD SHEET No.

	NAME	Sex	Age Yr	Age Mo	NUMBER: Addition	NUMBER: Multiplication	NUMBER: Three-Higher	VERBAL: Sentences	VERBAL: Vocabulary	VERBAL: Completion	SPACE: Flags	SPACE: Figures	SPACE: Cards	WORD FLUENCY: First Letters	WORD FLUENCY: Four-Letter Words	WORD FLUENCY: Suffixes	REASONING: Letter Series	REASONING: Letter Grouping	REASONING: Pedigrees	MEMORY: First Names	MEMORY: Word-Number	Composite Scores on Primary Abilities: N	V	S	W	R	M	Percentile Ranks on Composite Scores: N	V	S	W	R
26	PA				14	37	32	15	24	21	24	26	14	41	9	4	10	10	12	3	3	73	60	64	54	32	6	23	18	35	27	12	05
27	RR				7	4	29	15	17	20	2	0	2	38	12	12	7	7	19	5	3	40	52	4	62	33	8	06	24	01	07	14	16
38	RM				15	24	2	6	7	19	24	25	19	22	4	5	6	6	15	6	3	81	32	68	31	27	9	21	01	34	01	06	15
49	SG				14	15	30	17	19	30	42	44	21	26	10	2	17	12	15	7	2	79	66	107	38	44	9	26	20	80	06	28	17
50	VJ				11	32	44	10	18	27	36	39	26	38	2	6	4	13	23	8	0	87	55	101	46	40	8	37	14	76	13	22	12
51	VR				18	25	33	6	7	14	21	27	24	35	9	6	7	11	11	13	3	70	27	12	90	29	16	17	01	41	20	09	65
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of the total group. It is interesting to note that students who were unusually low in most factors seemed to do best in the Spatial factor. As it turned out, the Spatial factor was the only one in which the group compared favorably with the norms. Table fourteen lists the median percentile ranks of the group for the six factors.

TABLE 14

MEDIAN PERCENTILE RANKS FOR THE TOTAL GROUP

Factor	Median % Rank
1. Number	24
2. Verbal	7.75
3. Spatial	43
4. Word Fluency	7.67
5. Reasoning	19.25
6. Memory	17.00

In comparing this group to the norms it can be seen that the group is most inferior in the Verbal and Word Fluency factors and that the medians for these two are but eight hundredths of a point apart. Reasoning and Memory are next in line and are but 2.25 percentile points apart. The Number factor is at the 24th percentile while the Spatial factor is much farther up the scale (nineteen percentile points) and seems to stand alone.

Thus in comparing this group with the students attending Junior and Senior High Schools in Chicago, it can be

concluded that this Kilbourn Junior Trades Group does almost as well in the Spatial factor but does poorly in the other five factors, being weakest in the factors related to language abilities.

In evaluating the primary mental abilities of the total group the same procedure as used with the pretest group was employed. However, in this case all the primary mental abilities were compared with each other. This meant fifteen different combinations. The same process of equalizing scales of composite score obtained on the various factors was employed. The nature of the Word Fluency factor makes it impossible to set a highest possible score. Since the scores depend on lists of words constructed by the students, there is no limit that can be established. To facilitate equalizing, the highest possible score obtained by a member of this group was accepted as the highest possible score.[42]

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[42] This procedure was suggested by Dr. George Willett of the Marquette University faculty. It was also approved by Mrs. Virginia Brown, a statistician and member of the University of Chicago faculty, who has worked under Dr. L.L. Thurstone on the test

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While this method was the most acceptable it did create an imperfection in results. There is no question but that the accepted highest possible score of seventy is quite low. Thus in setting up the proportion with W as the denominator,

a quotient resulted which was too high. As a result of this students were probably overrated. Thus in comparing means between factors a superiority may result that does not actually exist.

Appendix C is a tabulation of the calculations involved in determining the level of confidence of the differences found. Table fifteen is a summarization of those findings. To read this table one has but to go in from the top and side starting with the two factors he wishes to compare. The square in which the two columns intersect contains the pertinent data. The letter indicates which of the two factors the total group was superior in; the decimal number indicates the difference between the means of the two factors while the percentile score indicates the level of confidence. Thus in comparing the Spatial factor with the Reasoning factor, one can locate either factor at the top or the side. Taking one from each column and finding where they intersect, one finds the following data: "S, 15.90, 5%". Thus the group was superior in their Spatial ability. The difference between means was 15.90 points. This difference was significant at the 5% level of confidence.

The study of the difference between means revealed the following information. (1) The differences between the mean of the Word Fluency factor and the other five factors showed the group to be superior in Word Fluency every time

TABLE 15

Summarization of Comparisons of 15 Combinations of Pairs of Factors for Total Group

	Number	Verbal	Spatial	Word Fluency	Reasoning	Memory
Number		V 7.52 50%	S 32.45 1%	W 61.61 1%	R 13.77 5%	N 8.10 50%
Verbal	V 7.52 50%		S 17.19 5%	W 30.65 1%	R 3.48 50%	V 7.82 5%
Spatial	S 32.45 1%	S 17.19 5%		W 25.16 1%	S 15.90 5%	S 28.65 1%
Word Fluency	W 61.61 1%	W 30.65 1%	W 25.16 1%		W 20.74 1%	W 20.71 1%
Reasoning	R 13.77 5%	R 3.48 50%	S 15.90 5%	W 20.74 1%		R 9.42 1%
Memory	N 8.10 50%	V 7.82 5%	S 28.65 1%	W 20.71 1%	R 9.42 1%	

Letter indicates which of two factors superior
Number indicates difference between means
Percentile score - indicates level of confidence of differences between means.

when compared with themselves. The differences were very significant. That is, in each comparison of a factor with the Word Fluency factor the differences were significant at the one per cent level of confidence. It must be remembered, however, that findings concerning the Word Fluency factor must be accepted with the reservations previously mentioned. (2) The Spatial factor ranked second in superiority. Outside of the Word Fluency factor the mean of the group for the Spatial factor was greater than the means of the other four factors. The differences between the means of the Spatial factor and the Reasoning and Verbal factors were significant (i.e., at the five per cent level of confidence) while the differences between the mean of the Spatial factor and the Number and Memory factor were very significant. (3) At this point the differences are not too clearly defined. The Reasoning factor is next in line. Its difference between means is very significantly superior to the Memory factor and significantly superior to the Number factor. Though it was found to be superior to the Verbal factor, this result is probably due to chance since the level of confidence was found to be only fifty per cent. (4) The mean of the Verbal factor was greater than the mean of the memory factor. This difference was not found to be significant. The level of confidence being fifty per cent. (5) The mean of the Number factor was

greater than that of the Memory factor but the difference was significant at the fifty per cent level.

Group one--Students who are superior in language intelligence. After an evaluation of the primary mental abilities of the total group investigation was directed toward certain students selected from the total group. Group one was composed of six boys who had obtained higher scores in the language than nonelanguage part of the California Test of Mental Maturity.

As a criterion for superiority in language, a minimum of sixteen I. Q. points over the non language score was selected. The mean difference was 20.5 I. Q. points with the greatest difference being 26 I. Q. points. The language I. Q. for the group ranged from 77 to 98 with a mean language I. Q. of 88.66. The non language I. Q. of the group ranged from 61 to 97 with a mean non language I. Q. of 74.83.

Calculations to evaluate the test results can be found in Appendix C. A summary of these findings is shown in Table 17. This table is read in the same way as Table 15. As might be expected, results were not as clearly defined with a group of six as with thirty one. When working with the total group, results were significant at the one, five, level. In working with this small group t scores at the two and ten per cent level of confidence appeared. Besides this, some differences were so small that a t score smaller than that required to meet the 50% level were obtained.

TABLE 16

GROUP ONE

Subject	Lang. I.Q.	Non-Lang. I.Q.	Diff.
BH	93	76	17
KT	97	77	20
NG	89	73	16
PA	82	61	21
RR	98	75	23
VJ	93	67	26

One conclusion that is quite evident is that those who have a higher language I. Q. demonstrate this superiority in the two language factors. The group did best in the Word Fluency factor. However the difference between the means of this factor and the Spatial factor revealed a t score for ten per cent level of confidence. Results obtained with the total group were "very significant".

The Verbal factor had a mean superior to all except the Word Fluency factor. However, t scores between means of it and the Number factor reached only the ten per cent level while the differences found between the Verbal and Spatial factor appear to be greatly subject to the influence of pure chance.

The Spatial factor was surpassed by the two factors previously mentioned but surpassed the other three factors.

TABLE 17

Summarization of Comparisons of 15 Combinations of Pairs of Factors for Group One

	Number	Verbal	Spatial	Word Fluency	Reasoning	Memory
Number		V 41.33 10%	S 34.33 10%	W 102.33 5%	R 23.83 50%	M 2.66
Verbal	V 41.33 10%		V 6.17	W 41.33 1%	V 9.83 10%	V 24.83 1%
Spatial	S 34.33 10%	V 6.17		W 56.66 10%	S 6.16 over 50%	S 24.83 50%
Word Fluency	W 102.33 5%	W 41.33 1%	W 56.66 10%		W 38.00 2%	W 34.16 1%
Reasoning	R 23.83 50%	V 9.83 10%	S 6.16 over 50%	W 38.00 2%		R 12.83 1%
Memory	M 2.66	V 24.83 1%	S 24.83 50%	W 34.16 1%	R 12.83 1%	

Letter indicates which of two factors superior
Number indicates difference between means
Percentile score indicates level of differences between means
Where no percentile score is indicated the level of significance was less than 50%

However, not once did this superiority satisfy five per cent level criterion.

The Reasoning factor was superior to the Memory factor at the one per cent level of significance but its superiority to the Number factor reached only the fifty per cent level.

Though it is dangerous to rate the group according to which factors it did best in, a clearer picture might be presented if the various levels of confidence between factors are noted. With this in mind the following ranking can be offered: 1) Word Fluency 2) Verbal 3) Spatial 4) Reasoning 5&6) Memory and Number.

In order to obtain a more realistic comprehension of the mental makeup of the sub groups, individual cases have been selected, which in the writer's opinion, most closely typify their respective groups. The most representative subject in group one was N.G.

N.G. had a total I. Q. of 83. His non language I.Q. was 73 while his language I.Q. was 39. This constituted a 16 point difference as measured by the California Test of Mental Maturity. N. G. was an average reader. His reading age 12-2 was but two months below his mental age, 12-4. His total grade level in reading was 7-2. This was broken down into vocabulary grade of 7-2 and a comprehension grade level of 7-0. All reading scores were obtained from the

Progressive Achievement Test.

In reviewing his scores on the Chicago Test of Primary mental abilities he was found to have fallen into the fifty-eighth percentile in Word Fluency ability. Other percentile ranks showed him to be at the forty-ninth percentile in Spatial Relations, at the thirty-third percentile in Verbal ability, at the sixteenth percentile in both Reasoning and Memory and only at the first percentile in Number ability. Note that the Verbal, Spatial, and Word Fluency factors appear to be grouped together above the other three factors. The superiority in these three factors is typical of results found with group one.

Percentile rank scores indicate N.G.'s relationship to the norms and should not be confused with composite raw scores which were used in group calculations to determine how the group compared (with itself) in the various test factors. For the other selected cases the same interpretation of percentile rank is indicated. In addition, the same tests for measuring intelligence and reading ability were used throughout.

Group two--Students who are superior in non-language intelligence. Group two consisted of six boys who scored better in the non-language phase of the California Test of Mental Maturity than in the language phase. The difference ranged from fourteen to thirty two points with the mean

difference being 19.16 I. Q. points. The language I. Q. for the group ranged from sixty to eighty one with a mean language I. Q. of 71.33. The non-language I.Q.'s ranged from 78 to 105 with a mean of 90.50. Table eighteen lists the subjects.

TABLE 18

GROUP TWO

Subject	Lang. I.Q.	Non-Lang. I. Q.	Diff.
PG	72	86	14
GR	81	96	15
KD	73	105	32
BHa	60	78	18
DT	66	82	16
ZR	76	96	20

These subjects were also selected with the intentions of pairing to make further comparison. A minimum of fourteen points difference was arbitrarily accepted as indicative of an individual with superior intelligence in the non-language phase.

Table nineteen indicates the statistical results relevant to group two. In general the findings are inconclusive in that they fail to demonstrate any clearly defined trend throughout. Out of the fifteen combinations of factors results show that nine of the comparisons have differences in

TABLE 19

Summarization of Comparison of 15 Combinations of Pairs of Factors for Group Two

	Number	Verbal	Spatial	Word Fluency	Reasoning	Memory
Number		N 22.83 10%	S 35.50 50%	W 30.00 5%	R 3.66 50%	N 8.00 50%
Verbal	N 22.83 10%		S 43.33 5%	W 32.50 1%	R 15.00 1%	M 6.16 50%
Spatial	S 35.50 50%	S 43.33 5%		S 3.00 over 50%	S 22.50 50%	S 30.66 50%
Word Fluency	W 30.00 5%	W 32.50 1%	S 3.00 over 50%		W 11.66 50%	W 11.66 10%
Reasoning	R 3.66 50%	R 15.00 1%	S 22.50 50%	W 11.66 50%		R 5.00 50%
Memory	N 8.00 50%	M 6.16 50%	S 30.66 50%	W 11.66 10%	R 5.00 50%	

Letter indicates which of two factors superior
Number indicates difference between means
Percentile score indicates level of confidence of differences between means

means that may have been due purely to chance, while two other comparisons had t values at the ten per cent level of confidence.

However there are some important findings that should be noted. It is clear that the group is weakest in the Verbal factor. The Word Fluency and Reasoning factors are superior to the Verbal factor at the one per cent level while the Spatial factor shows superiority at the five per cent level. At no time was the Verbal factor superior to any other.

Though it was possible in only one comparison to find a significant difference, the spatial factor in every comparison had a mean greater than the other five. The Word Fluency factor was significantly superior to either the Number or Verbal factors and had a mean greater than either Reasoning or Memory. The Reasoning factor was superior to the Number and Memory factor and very significantly so to the Verbal factor.

The above statistical findings, though not conclusive, indicate a superiority for group two in Spatial, Word Fluency and Reasoning factors in comparison to the other three.

Z. R has been selected as being most representative of group two. He is low in language I. Q. and is retarded in reading. His total I. Q. is 83. This has been broken

down into a non-language I. Q. of 96 and a language I. Q. of only 76, a difference of twenty points.

Z. R's reading vocabulary is that of a fourth grader (4-5). His reading comprehension is equal to that of a sixth grader (6-0). This gives him a reading grade level of 5-1. Compared with his mental age of 12-2, Z. R is retarded 25 months in reading.

What type of a Primary Mental abilities does such an individual present? In Memory, Z. R. was somewhat outstanding for his group. He reached the sixty-fifth percentile in this factor. However, the rest of his scores fall into the expected pattern. In Spatial relations Z. R. ranked at the forty-first percentile and at the twentieth percentile in Word Fluency. Other percentile rankings include Number ability seventeen percentile; Reasoning ability, ninth percentile and Verbal ability first percentile. The Memory and Number abilities rank higher here than for most individuals in groups one and three. This appears to be a fundamental difference between the groups.

A comparison of groups one and two. After noting the primary mental abilities of these two groups it is natural to ask, "What is the difference in such abilities between those who do better in language intelligence tests and those who do better in a non language measure of intelligence.

Table twenty lists the subjects so that it is easy to

TABLE 20

The Pairings of Groups One and Two

Group One					Group Two				
Subj.	M.A.	Lang. I.Q.	Non Lang. I.Q.	Diff.	Subj.	M.A.	Lang. I.Q.	Non Lang. I.Q.	Diff.
BH	12-7	93	76	17	PG	12-5	72	86	14
KT	12-7	37	77	20	GR	12-8	81	96	15
NG	12-4	89	73	16	KD	12-3	73	105	32
PA	10-9	82	61	21	BHa	11-0	60	78	18
RR	11-9	98	75	23	DT	11-10	66	82	16
VJ	12-3	93	67	26	ZR	12-2	76	96	20

discern the basis upon which the subjects were paired. Note that for every individual in group one there is a mate who qualifies for group two who has a mental age within three months of his opposite. The mean mental age as measured by the California Test of Mental Maturity for both groups one and two is 12-0. This is indicative of very close pairing.

Group one ranged from sixteen to twenty six points higher in their language I. Q. while group two range from fourteen to thirty two points higher in non language I. Q. Group one had a mean superiority of 20.5 I. Q. points while group two had a mean superiority of 19.2 I. Q. points in the opposite direction.

Calculations were carried out to determine which group

had a mean score higher than the other and whether the differences indicated were statistically significant. A record of the computations indicating the method may be found in the last part of Appendix C.

Table twenty-one indicates that it was almost impossible to obtain any difference between the two groups that would offer any conclusive evidence. As might be expected Group one was significantly superior to Group two on the verbal factor. However after this point there is no reason to believe that chance might not have influenced results. Every difference except the above mentioned Verbal factor has a t value for the fifty per cent level of confidence. Also to be noted is that each group was superior in three factors.

TABLE 21

RESULTS OF COMPARISON OF GROUPS ONE AND TWO

P.M.A. FACTOR	GROUP WITH HIGHER MEAN FOR FACTOR	LEVEL OF CONFIDENCE OF DIFF. BETWEEN MEANS
Number	Two	50%
Verbal	One	5%
Spatial	Two	50%
Word Fluency	One	50%
Reasoning	One	50%
Memory	Two	50%

Thus it is more difficult to determine any conclusive pattern except that the greatest differences were found in the two factors (Verbal and Word) which would be most likely to be indicative of language vs. non language group differences. In addition, this may have been influenced by the method of determining norms for the Word factor. It must be kept in mind that there were only six members to each group and that results are necessarily interpreted in terms of such a small group.

Group three -- Average and above average readers. Most students at the Kilbourn Junior Trades School read below their capacity. When an individual reads to capacity he will have a reading age which is close to his mental age.

It was thought to be worthwhile, therefore, to include in the study those students who read beyond what their mental age would indicate. For this group seven boys were selected whose reading age ranged from four to twenty nine months above their mental age. The mean difference between reading age and mental age, was eighteen months. While this is a somewhat abnormal amount of difference in terms of what we usually look upon as advanced, it is still an even more select group in terms of the school population from which it was taken. However, to prevent any criticism this group has been called "average and above average readers" and will be considered as such. Table twenty-two indicates the makeup of the group.

TABLE 22

GROUP THREE

Subject	R.A.	M.A.	Diff. in Months
RR	13-7	11-9	22
PA	13-2	10-9	29
SG	13-5	12-6	11
NA	13-5	11-5	24
PG	12-9	12-5	4
VJ	13-3	12-3	12
MW	14-3	12-4	23

The group ranges in reading age from 12-9 to 14-3 with a mean reading age of 13-5. In mental age on the California Test of Mental Maturity the range was from 10-9 to 12-6 with a mean M.A. of 11-11.

Group three presented a pattern which was not too far from what might be expected. The Word Fluency factor gave higher scores than all other factors. Outside of the Spatial factor, the superiority was significant at the one per cent level. While the superiority of the Spatial factor was not statistically proved, it showed itself to be superior in every case except when compared with the Word Factor. This was a good reading group. It is not unusual then, that the group should do well in verbalization. The test verifies these expectations. In the other three factors the group does poorly, showing exceptional weakness in the Number factor. Table twenty-three summarizes the above statements.

TABLE 23

Summarization of Comparison of 15 Combinations of Pairs of Factors for Group Three

	Number	Verbal	Spatial	Word Fluency	Reasoning	Memory
Number		V 34.86 2%	S 40.00 50%	W 97.86 1%	R 23.00 5%	M .71 50%
Verbal	V 34.86 2%		S 3.86 50%	W 35.86 1%	V 6.43 50%	V 19.00 5%
Spatial	S 40.00 50%	S 3.86 50%		W 41.14 10%	S 11.86 50%	S 27.57 50%
Word Fluency	W 97.86 1%	W 35.86 1%	W 41.14 10%		W 31.71 1%	W 28.43 1%
Reasoning	R 23.00 5%	V 6.43 50%	S 11.86 50%	W 31.71 1%		R 9.29 10%
Memory	M .71 50%	V 19.00 5%	S 27.57 50%	W 28.43 1%	R 9.29 10%	

Letter indicates which of two factors superior
Number indicates difference between means
Percentile score indicates level of confidence of differences between means

R. R. was a member of group three. His total I. Q. was found to be 89. This was made up of a 75 non-language I. Q. and a 98 language I. Q. This 23 point superiority in language intelligence was in line with his reading superiority. R. R. had a reading age 22 month's higher than his mental age of 11-9.

In measuring his Primary mental abilities, it was found that R. R.'s twenty-fourth percentile ranking in Verbal ability was his highest. For the Memory factor he ranked at the 18th percentile and for the Reasoning factor at the fourteenth percentile. For other three factors R. R. ranked below the seventh percentile. It might be repeated here, that percentile rank indicates a relation to the norms and presents a different aspect of the pattern than the other statistical results used in evaluating the group.

Group four--Inferior readers. Group four is made up of seven retarded readers. They range in reading age from 9-0 to 11-4. On the other hand their mental ages range from 11-0 to 12-8. Thus we have a group whose mean reading age is 10-4 and whose mean mental age is just short of 12-0. Individuals range in retardation from twelve months to twenty five months. This group has a mean retardation of 19.5 months. Thus we may safely classify them as inferior readers. Table twenty four lists the members of the group with their amounts of retardation.

The results found from group four are not too different from those of the other groups. Again Spatial and Word Fluency factors rank above the others. This time the group did better in Spatial Relations than in Word Fluency. However the difference here is not statistically significant. This is the reverse of group three except for the absence of statistical proof.

TABLE 24

GROUP FOUR

Subject	R.A.	M.A.	Diff. in Months
AW	10-4	11-10	18
BHa	9-0	11-0	24
GR	11-4	12-8	16
HE	9-2	11-2	24
KT	11-2	12-7	17
KD	11-4	12-4	12
ZR	10-1	12-2	25

Another result which again is not supported statistically is the reverse situation as far as the Number and Verbal factors are concerned. Group four was superior in Number Ability (excepting the two previous mentioned factors) and down in Verbalization. The opposite situation was the case for Group three. Table twenty five summarizes the findings of the test.

TABLE 25

Summarization of Comparison of 15 Combinations of Pairs of Factors for Group Four

	Number	Verbal	Spatial	Word Fluency	Reasoning	Memory
Number		N 30.71 50%	S 39.43 10%	W 23.14 50%	N 12.00 40%	N 24.14 50%
Verbal	N 30.71 50%		S 49.14 2%	W 30.71 2%	R 9.29 5%	M 3.86 50%
Spatial	S 39.43 10%	S 49.14 2%		S 11.14 50%	S 36.28 5%	S 44.71 2%
Word Fluency	W 23.14 50%	W 30.71 2%	S 11.14 50%		W 15.00 50%	W 14.00 10%
Reasoning	N 12.00 50%	R 9.29 5%	S 36.28 5%	W 15.00 50%		S 5.00 50%
Memory	N 24.14 50%	M 3.86 50%	S 44.71 2%	W 14.00 10%	R 5.00 5%	

Letter indicates which of two factors superior
Number indicates difference between means
Percentile Score indicates level of confidence of differences between means

A. W. was selected as a representative member of group four. His language and non-language I. Q.'s were approximately the same, 75 and 73 respectively. However, he was regarded 18 months in reading. His mental age was 11-10 and his reading age was 10-4. In vocabulary (5-3) and reading comprehension (5-8) he was between the fifth and sixth grade level. His percentile rankings supported this information.

In Spatial relation he ranked at the fifty-second percentile. His percentile rank score for the Number factor was forty-nine. He was at the eleventh percentile in Reasoning ability and was below the third percentile for both language factors and the memory factor. His inferiority in language abilities is clearly indicated.

A comparison of groups three and four. When the comparison between these two groups was made it was set up on the same basis as the previous comparison between groups one and two. Each individual was again paired with his opposite who had according to the California Test of Mental Maturity the same learning capacity. In no case was there more than three months difference in mental age. As pointed out before, the mental ages for group three ranged from 10-9 to 12-6 with a mean of 11-11. For group four the range spanned the ages 11-0 to 12-8 having a mean of 11-10. Note again that in pairing the two groups on this significant

basis their ranges and means were almost identical. Table twenty-six combines two previous tables to indicate the proximity of mental age and the great divergence in reading ability.

TABLE 26

THE PAIRINGS OF GROUPS THREE AND FOUR

Group Three				Group Four			
Subj.	Read. Age	M.A.	Diff. in Mo.	Subj.	Read. Age	M.A.	Diff. in Mo.
RR	13-7	11-9	22	AW	10-4	11-10	18
PA	13-2	10-9	29	BHa	9-0	11-0	24
SG	13-5	12-6	11	GR	11-4	12-8	16
NA	13-5	11-5	24	HE	9-2	11-2	24
PG	12-9	12-5	4	KT	11-2	12-7	17
VJ	13-3	12-3	12	KD	11-4	12-4	12
MW	14-3	12-4	23	ZR	10-1	12-2	25

The same computations were carried out as had been done when groups one and two were compared. The purpose here was to determine in which of the six factors average and better than average readers excelled and in which factors the inferior readers did better. The statistics for the six factors centered about the determination of the significance of the differences found between the means of these two groups.

Results here were somewhat more gratifying than in the previous comparison. Not only were more distinctive

differences found but these differences were found to be significant in two cases with an additional t value at the ten per cent level. Table twenty-seven summarizes these findings.

TABLE 27

RESULTS OF COMPARISON OF GROUPS THREE AND FOUR

P.M.A. FACTOR	GROUP WITH HIGHER MEAN FOR FACTOR	LEVEL OF CONFIDENCE OF DIFF= BETWEEN MEANS
Number	Four	50%
Verbal	Three	1%
Spatial	Four	50%
Word	Three	10%
Reasoning	Three	5%
Memory	Three	50%

There appears to be a pattern here which is worth noting. Group four excelled in only two factors. However there seems to be a relationship between these two factors in that they deal with abstract symbols which are presented to the subject for analysis and are of a different type than the Verbal, Word Fluency and Reasoning factors in which group three did so much better.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary. At the Kilbourn Junior Trades School in Milwaukee there are many students who failed to indicate any clear pattern of mental and academic makeup from the scores of the California Tests of Mental Maturity and the Progressive Achievement Test. On the California Test of I. Q. scores ranging from 26 points above their non-language I.Q. to 32 points below their non-language I. Q. On the Progressive Achievement Test students demonstrated reading ages ranging from 29 months above their mental age to 25 months below their mental age. Since there is pressure to place such students in regular Junior High Schools, it was thought worthwhile to investigate such groups of individuals in order to provide additional data which might aid in clarifying and solving problems of students demonstrating these inconsistencies.

Before carrying out the complete testing program planned, The Chicago Test of Primary Mental Abilities Ages 11 to 17 was administered to a pretest group of fourteen boys. The boys were found to be much superior in their Reasoning ability score as compared to the Memory factor. This superiority was found to be statistically significant. If such a difference existed, there might be other

superiorities and inferiorities which would indicate a pattern of mental makeup of the group. The remainder of the study attempted to discover just what these differences were and what patterns might be indicated from them.

Thirty-one subjects made up the final total group. From the test it was found that this group compared favorably in only one factor with the Chicago group from which the norms were established. The Kilbourn group scored only slightly lower (the forty-third percentile) than the norm group on the Spatial factor. For the other five factors the Kilbourn group was below the twenty-fifth percentile as measured by the table of norms. Thus the group demonstrated generally inferior primary mental abilities (Table 14).

A statistical comparison was then made to determine which of the six factors of the test netted the highest scores for the total group. The mean score received for each of the other factors was compared with the mean scores obtained for each of the other factors. Computations were then carried out to determine whether the differences between these mean scores were significant. In this and all further computations raw scores, adjusted to an equal scale determined on the basis of highest possible test scores were used.

Results of such computations indicated that the total

group scored highest in Word Fluency and Spatial Relations with statistically significant superiority in evidence. However, the superiority of the Word Fluency factor, though clearly indicated by calculations made, was subject to error brought about by the method used in making these calculations. The nature of the Word Fluency factor tests were such that no high score limit was set by the authors. The highest score obtained by a subject within the total group was accepted as the highest possible score. This tended to raise the scores made by all subjects and influenced the results of all calculations in which the Word Fluency factor participated. Following the Word Fluency and Spatial Relations factors were Reasoning, Verbal, Number and Memory factors in that order. The ranking of the last four factors received only limited statistical support.

From the total group smaller special groups were selected to make a more detailed study. Group one was made up of six boys who scored higher in their language intelligence tests than in their non-language as measured by the California Test of Mental Maturity. This group did best in the Word Fluency and Verbal factors and almost as well in Spatial Relations. The comparisons with other factors showed these differences to be generally statistically significant. The group was relatively poor in Memory and Number ability.

Group two, composed of six subjects who were superior

in non-language intelligence, did best in Spatial Relations, next best in Reasoning and Number ability respectively. The group scored lowest on the Verbal factor.

In comparing groups one and two, which were equal in mental ability according to the California Test of Mental Maturity, it was found that group one scored higher in the Verbal, Word Fluency, and Reasoning factors while group two demonstrated superiority in the Number, Spatial and Memory factors. However the superiorities were not generally conclusive enough to eliminate the possible influence of chance operating.

Group three was made up of seven subjects whose reading ability was greater than their mental ability as measured by the Progressive Achievements Tests and California Test of Mental Maturity respectively. This group did best in Word Fluency, Spatial Relations and Verbal abilities. They were poorest in Number ability and Memory.

Group four was the reverse of group three in that it had a poorer reading score than mental ability indicated should exist. These inferior readers did best in Spatial Relations and Word Fluency with Number ability not too far behind. The group was very poor in Verbal Ability.

Individuals of groups three and four were paired since the two groups had approximately the same mental age. From this comparison it was found that group three did better on

the Verbal, Word Fluency and Reasoning factors while group four did better on the Number, Spatial Relations and Memory factors.

Limitations of the Study. The nature of the study and certain techniques employed have created certain limitations which should be kept in mind when evaluating results. The statistical techniques are subject to question. In working with small samples one of the basic assumptions is that random sampling has taken place. In view of the fact that the sample drawn was extremely small and was not selected at random no conclusion can be drawn beyond the specific cases tested here.

The adjustments made to compensate for the inability to set a maximum score for the Word Fluency factor have affected results in which this factor has participated. In each case where the Word Fluency Factor was compared with other factors, the former was given an inflated value. Thus the superiority in Word Fluency which statistics bear out do not necessarily represent such superiority but rather must be viewed in terms of the adjustments made.

In addition, it was feared at the time of administration of the test that the inability of some subjects to read and understand the questions would invalidate test results. To prevent the possibility of such a mishap, close surveillance of subjects' efforts was made during practice tests. As a

result of close proctoring two subjects were dropped from the testing program for failure to demonstrate ability to read questions. However, in spite of this caution, it is possible that some of the poorer readers might have had reading difficulties with parts of tests without attracting the attention of the tester. This would have invalidated test scores.

While it is not believed that the above limitations make this study worthless, it is intended that all conclusions be viewed in terms of the uncertainty of findings resulting from the above limitations.

Conclusions and Suggestions for Further Study.

1. Group one, which was composed of subjects who demonstrated superior language intelligence when compared with their non-language intelligence as measured by the California Test of Mental Maturity presented a pattern of Primary Mental Abilities which was very similar to that of group three, which constituted subjects having a reading age equal to or greater than mental age as measured by the Progressive Achievement Tests and the California Test of Mental Maturity.

2. Group two, composed of subjects demonstrating superior non-language intelligence when compared with their non-language intelligence presented a pattern of Primary Mental Abilities very similar, to that of group four, which

was composed of subjects who had a reading age superior to their mental age. The tests listed above served as measurement devices for classifying these two non-language groups.

3. Groups one and three score higher in the Word Fluency, Verbal and Reasoning factors than do groups two and four.

4. Groups three and four score higher in Number ability than do the other groups.

5. None of the groups do well in the Memory factor.

6. The above conclusions receive only limited statistical support from calculations made.

7. The high scores obtained by the poorer language groups in Word Fluency are highly questionable.

8. Regardless of the special group, scores for the Spatial Relations factor were generally higher than scores for other factors. This evidence of strength might serve as a cue for further investigation dealing with the relationships of Spatial Relations to various mechanical operations. In the manual for the Primary Mental Abilities test, Dr. L. L. Thurstone points out that the educational implications which a high or low score in any of the factors might have is open to debate. He suggests this type of study as a whole new field for investigation.

9. As far as educational implications for this study

are concerned, there is not sufficient data to suggest any specific educational program. However, if additional study confirms the findings herein, an experimental educational program might provide some valuable information. A comparison of the effects of a more highly verbalized educational program with a highly non-verbalized type of education upon groups similar to the language and non-language groups of this study might be of service to our educators. If patterns of strengths and weaknesses among any of the six factors receive greater statistical support from further study, an investigation concerning the educability of any single or combination of factors might be in order. Such studies might, for example, attempt to answer the following questions: 1) Can Spatial ability be increased through education and, if so, what educational program and methods produce best results? 2) Is a different type of curriculum for the various retarded students in Junior Trades Schools or in special classes in regular Junior High Schools necessary to increase these abilities? If so, what are the distinguishing factors in such a curriculum?

The defining of these Primary Mental abilities has opened the door for almost unlimited research. It is hoped that a sizeable portion of such investigation be carried on with the types of subjects discussed in this study.

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APPENDIX A

A COPY OF THE TEST USED

NAME..... N 100

THE AMERICAN COUNCIL ON EDUCATION

THE CHICAGO TESTS OF PRIMARY MENTAL ABILITIES

For Ages 11 to 17

Prepared by

L. L. THURSTONE, The University of Chicago

and

THELMA GWINN THURSTONE, The Chicago Teachers College

with the cooperation of

The Bureau of Child Study of the Chicago Public Schools

Published by
The American Council on Education
744 Jackson Place, Washington, D. C.

ADDITION

Below are two columns of numbers which have been added. Add the numbers for yourself to see if the sums are correct.

	16	42
	38	61
	45	83
	99	176
R	—	
W		—

The first sum is right so the space in the R row is marked. The second sum is wrong so the space in the W row is marked.

Check the sums of the columns below. If a sum is right, mark the space in the R row. If a sum is wrong, mark the space in the W row.

	17	35	63
	84	28	17
	29	61	89
	140	124	169
R			
W			

Stop here. Wait for further instructions from the examiner.

MULTIPLICATION

Below are two multiplication problems. Multiply the numbers for yourself to see if the products are correct.

	64	39
	7	4
	448	166
R	▬	▪▪▪
W	▪▪▪	▬

The first answer is right so the space in the R row is marked. The second answer is wrong so the space in the W row is marked.

Check the answers in the problems below. If the answer is right, mark the space in the R row. If the answer is wrong, mark the space in the W row.

	57	46	29
	6	8	7
	342	358	193
R	▪▪▪	▪▪▪	▪▪▪
W	▪▪▪	▪▪▪	▪▪▪

Stop here. Wait for further instructions from the examiner.

THREE-HIGHER

In the row of numbers below, 10 is marked because it is 3 more than the number 7 which is just before it. The number 8 is also marked because it is 3 more than the number just before it.

5 7 **10** 12 14 11 3 5 **8** 12

Here is another row of numbers. Mark every number that is exactly 3 more than the number just before it.

4 11 14 10 9 12 16 8 10 3 15 18 9

You should have marked 14, 12, and 18.

Here are more problems for practice. In each row mark every number that is exactly 3 more than the number just before it. Work as fast as you can.

3 7 10 14 11 9 12 13 16 8 2 1

5 9 11 14 8 9 7 10 8 5 9 12

4 6 9 2 5 8 15 16 21 19 22 18

13 15 19 24 23 26 18 14 11 13 19 12

7 10 12 14 28 23 16 15 18 13 16 5

15 19 21 26 29 22 25 5 8 7 11 4

Stop here. Wait for further instructions from the examiner.

The American Council on Education

THE CHICAGO TESTS OF PRIMARY MENTAL ABILITIES

FOR AGES 11 to 17

Prepared by

L. L. THURSTONE, THE UNIVERSITY OF CHICAGO
and
THELMA GWINN THURSTONE, THE CHICAGO TEACHERS COLLEGE
with the cooperation of
THE BUREAU OF CHILD STUDY OF THE CHICAGO PUBLIC SCHOOLS

Name_____

School_____ Room_____

Grade_____ Date_____

When were you born? Month_____ Day_____ Year_____

How old were you on your last birthday?_____

Sex_____ Present Age_____ Years_____ Months

Do not open this booklet until you are told to do so.

Published by
THE AMERICAN COUNCIL ON EDUCATION
744 Jackson Place, Washington, D. C.

ADDITION

Add each column.

If the sum is right, mark the space in the R row.
If the sum is wrong, mark the space in the W row.

	61	31	66	73	13	48	88
	34	59	73	29	39	45	29
	78	52	15	56	99	17	69
	53	68	38	33	32	82	98
	226	200	202	211	183	192	284
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	86	69	71	44	75	26	99
	49	44	37	49	54	44	77
	54	89	66	23	36	75	82
	22	84	55	48	17	51	68
	111	286	129	164	162	196	316
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	25	43	31	59	52	68	78
	46	34	73	29	56	33	56
	92	89	13	39	99	32	76
	57	32	48	45	17	82	35
	220	198	185	192	124	225	245
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	95	79	89	97	13	26	44
	49	22	64	35	92	99	77
	44	84	61	66	31	26	86
	37	55	34	73	36	62	68
	205	240	258	271	172	213	275
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	97	13	26	44	75	51	81
	92	99	77	82	68	39	46
	26	86	32	84	39	92	43
	86	79	99	32	57	32	48

	32	97	23	71	48	24	89
	98	63	36	46	59	85	95
	22	76	41	67	17	94	55
	91	57	65	62	16	47	79
	243	303	165	236	150	250	218
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	26	81	75	18	59	64	83
	86	39	47	15	44	61	34
	34	84	55	57	78	34	41
	99	79	19	96	89	19	16
	345	293	196	186	280	188	174
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	32	98	22	91	28	81	89
	97	63	76	57	63	39	86
	23	36	41	65	62	67	69
	71	46	67	62	87	52	71
	243	243	196	295	260	239	315
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	75	51	43	31	59	52	68
	82	68	73	29	56	33	47
	99	32	39	99	32	55	56
	87	23	17	82	19	33	58
	243	174	182	251	146	173	239
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	31	59	42	68	75	78	23
	43	73	29	56	33	47	56
	92	43	13	39	45	32	55
	79	57	32	48	99	17	82

If the answer is right, mark the space in the R row.

If the answer is wrong, mark the space in the W row.

	68	82	72	57	65	92	58
	3	3	9	4	9	4	7
	204	236	658	208	585	368	406
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	89	69	43	26	26	73	29
	6	4	9	6	8	4	8
	534	286	387	146	198	292	252
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	81	47	84	48	68	47	46
	3	8	3	8	3	7	9
	233	376	242	384	194	329	404
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	98	36	59	95	37	54	76
	4	6	3	6	9	4	8
	382	236	177	570	353	236	608
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	42	78	76	54	63	87	97
	8	4	6	4	6	3	6
	336	312	446	206	368	241	582
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	78	56	72	24	42	94	89
	7	9	8	8	6	9	6
	566	504	586	182	272	846	534
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	73	92	32	64	58	86	67
	8	3	8	7	7	4	6
	604	276	246	448	406	344	402
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	36	82	98	38	36	98	93
	8	7	6	7	9	6	7
	268	574	598	286	304	588	641
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	52	38	67	73	89	32	73
	8	4	3	7	6	7	6
	406	142	201	491	524	214	458
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

	65	79	56	52	34	87	76
	6	8	6	7	8	7	4
	390	632	316	344	292	589	304
R	:::::	:::::	:::::	:::::	:::::	:::::	:::::
W	:::::	:::::	:::::	:::::	:::::	:::::	:::::

THREE-HIGHER

In each row mark every number that is exactly 3 more than the number just before it.

NAME _____

S	R	W	S

11	12	9	12	3	5	7	10	14	20	24	27	16	21	2	8	14	6	9	11	17	20	21	18	21	5	29	21	24
11	14	15	2	5	7	15	22	25	27	23	22	24	19	26	12	15	18	22	25	27	29	24	21	19	22	17	3	11
26	3	13	9	7	10	13	19	21	18	12	7	6	1	17	19	2	14	17	3	11	5	8	9	1	4	2	6	15
12	13	16	2	4	8	25	19	21	27	26	29	28	2	14	18	21	22	6	12	15	17	19	3	2	16	4	7	10
12	3	11	2	24	16	19	11	16	17	20	26	23	1	18	11	19	21	24	26	16	12	13	16	1	24	27	28	22
15	18	15	19	21	6	4	12	13	5	9	12	18	26	5	7	16	9	11	14	8	11	16	22	26	29	13	18	12
29	23	2	4	7	11	14	1	25	17	20	21	9	23	22	17	20	19	14	11	14	18	17	20	23	24	9	7	10
5	14	12	24	23	18	19	26	2	7	15	18	21	9	2	8	6	14	12	15	16	27	23	1	9	12	18	21	6
8	6	14	18	20	23	19	24	27	5	1	8	12	19	27	20	23	19	22	12	11	14	17	16	19	3	18	22	24
28	29	29	16	11	14	8	3	12	19	21	24	17	22	11	18	4	7	5	19	13	16	12	14	17	24	26	29	26
16	15	17	20	21	13	16	19	22	24	16	8	3	11	22	24	14	12	15	16	26	19	29	8	11	5	8	7	14
2	8	11	5	9	12	14	17	24	26	29	2	6	1	16	15	12	13	16	21	27	18	7	10	1	4	7	10	12
17	3	11	15	2	5	7	16	19	2	4	8	15	26	4	9	12	14	13	17	12	15	21	24	26	29	18	15	12
14	11	12	8	3	6	1	19	22	25	28	16	20	13	12	13	18	16	19	14	29	22	25	20	13	16	1	5	8

NAME..... V

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SENTENCES

In the sentence below the last word is missing. The missing word occurs in the row of words under the sentence.

The roof which had just been mended did not leak during the heavy

cyclone drizzle **rain** wind sleet

"Rain" has been marked because it is the best word to complete the sentence.

In the sentence below the last word is missing. Mark the word which completes the meaning of the sentence.

He could not have found his way through the forest without the aid of a

rope guide sleigh idea command

You should have marked "guide" because it completes the meaning of the sentence.

In each sentence below the last word is missing. Mark the word which completes the meaning of the sentence.

In order to keep his identity unknown he wore a

cloak ring tunic mask glove

Today much of our clothing is designed to make a fashionable appearance rather than for

style protection children sale dresses

Stop here. Wait for further instructions from the examiner.

VOCABULARY

The first word in the following line is "big."

big	ill	large	down	sour

One of the other words means the **same** as "big." The word "large" has been marked because it means the same as "big."

The first word in the following line is "ancient." Mark one of the other words that means the **same** as "ancient."

ancient	dry	long	happy	old

You should have marked "old" because it means the same as "ancient."

In each of the following lines mark the word that means the **same** as the first word.

quiet	blue	still	tense	watery
safe	secure	loyal	passive	young
brave	hot	cooked	red	courageous

Stop here. Wait for further instructions from the examiner.

COMPLETION

Read the definition below. Think of the word which fits the definition. The **first** letter of the word is in the row of letters under the definition.

The first meal of the day.

A ═ B ▬ C ═ D ═ E ═

The word is "Breakfast." "B" is marked because it is the first letter of the word "Breakfast."

Do the following example:

A place or building for athletic exercises.

D ═ G ═ H ═ T ═ V ═

The word is "Gymnasium." You should have marked "G" because it is the first letter of the word "Gymnasium."

Do the following examples in the same way:

The red fluid which circulates in the veins and arteries of man.

B ═ C ═ D ═ F ═ G ═

A one-cent piece made of copper.

A ═ B ═ E ═ H ═ P ═

A small or portable bed, as of canvas stretched on a frame.

B ═ C ═ H ═ N ═ T ═

Stop here. Wait for further instructions from the examiner.

Mark the word which best completes the meaning of the sentence.

If an Eskimo woman allows her seal-oil lamps to smoke, she will be considered a poor housekeeper and will be criticized by her

lamps smoke Eskimo family igloo

Cables and telegrams are often sent in code; a code shortens the message because a few letters may represent eight or ten

cables codes papers telegrams words

A newspaper which takes a decided stand on controversial issues runs the risk of displeasing many of its

editors readers owners newsboys poets

Roosters fight with their spurs—spurs are their natural

combat feet victories weapons beaks

The jury returned the verdict after so short an interval that the judge thanked them for their

agreement fairness leniency promptness care

Very thirsty from his exertion, he directed his steps toward the stream, only to find the undergrowth so thick that he could not get near the

bottom banks current bushes waves

A middle-aged man walked almost every day with three dogs—two Scotties and one of unidentified

color ownership breed title size

The cliff dwellers lived in caves which they had hewn out of

tiles sand brick stone concrete

It is the practice in the army to play "The Star-Spangled Banner" at the end of a musical

band salute program director song

We stood in line for nearly two hours before we were admitted to the grounds which were already packed with a dense throng of

benches galleries visitors crowds cattle

Some families live under conditions of extreme crowding and lack of

candles privacy interest automobiles radios

Speedier recovery from surgical operations seems promised by the discovery of a new

hospital treatment doctor patient nurse

Municipal fire departments, when called upon to fight fire outside the city limits, almost invariably charge for the

property service insurance success damage

Many parents who are very gifted musically have children who do not possess that

training ancestry education handicap talent

If anything annoys a very busy man, it is a telephone call during business hours from someone who wants a

telephone lawyer plan favor number

My fountain pen ran dry, and I was forced to stop writing in the middle of a word for lack of

education ideas interest strength ink

The nursery school is not a substitute for the home, but it is intended to aid and supplement home

training cradles nurseries planning meals

If the pilot of an airliner meets too much ice, he can ascend or descend to different flight levels until he finds a warmer

engine water transport temperature day

Residential districts are often reached by winding roads designed to discourage

traffic friends thieves privacy wealth

Electrical appliances in the household lift the burden of heavy chores from the

cooking housewife floors income broom

S2	S1	S

NAME_____

His grandfather was a country doctor who acted both as surgeon and physician in thinly settled

countries roads hospitals districts cities

Although ordinarily we think bamboo to be almost as oriental as elephants, the southern part of our country is well adapted to its

sale flexibility reeds beauty growth

Half a million laborers, skilled workers, and engineers are needed to build highways across the continent for automobile

repairs traffic designers accidents sales

In the encyclopedia some subjects are discussed briefly, others in detail, covering three or four closely printed

volumes discussions details pages topics

Census enumerators are instructed to check facts wherever possible, but they cannot catch all the

census occupations figures errors years

A vaccine and a germ-fighting lamp have been found which may prove practical means of preventing influenza

treatment epidemics vaccination prevention cure

A cubic mile of ordinary fog, which consists of tiny drops of moisture like fine spray, contains less than a gallon of

fog air water clouds spray

He has been told since childhood that he is like his father, so he has taken his father for a

friend protector brother model doctor

A summary is convenient for use and contains all the principal ideas which were presented in the full-length

synopsis library book excerpt page

Some people cannot afford proper dental care even with the most careful

The noted photographer could not have accomplished a thing without his wife, who assisted him in his business and was largely responsible for his

failure success description painting writing

Because instalment prices are higher than cash prices, one should know how to determine the rate of interest he is really paying on this type of

interest loan price cash rate

We must learn to utilize leisure time so as to develop pleasurable hobbies and to avoid the evils of

poverty idleness illness drugs sorrow

The discovery of vitamins and their importance to health has helped to arouse new interest in

children forestry gymnastics education diet

His life-long ambition was to become a famous surgeon, and, at last, his desire had reached its

decision recovery surgery fulfillment home

Although the bite of such spiders is usually fatal, this time the result was not

recovery poison life pain death

Many people believe that war is stupid and unnecessary and that to die in battle is the greatest

uselessness handicap patriotism bravery honor

Motion picture theatres have invaded villages and, with improved means of travel, are now accessible to rural people and play a role in their

travel village production recreation unions

At the rate soil is washed into reservoirs, in the next 50 years one third of the existing reservoirs in the United States will be silted beyond

usefulness depth capacity flooding soil

A camera club was composed of blind members who learned how to take,

In each row of five words below, mark the word which means the same as the first word in that row.

moist	curt	humane	damp	moderate
quick	major	hasty	narrow	vigorous
annual	variable	yearly	listless	untenable
splendid	expansive	gay	rigid	excellent
customary	nocturnal	radial	prime	usual
fluid	livid	dead	liquid	talkative
idle	lazy	cross	wild	useful
deserted	drab	absurd	disturbed	abandoned
rare	holy	crass	infrequent	weak
contented	nasty	continuous	defamatory	satisfied
enraged	pleasing	poor	angry	domestic
beneficial	artificial	tamable	helpful	piquant
moldy	tonic	musty	shapeless	mute
rasping	harsh	minute	kinaesthetic	marshy
dietary	diagrammatic	amorphous	dietetic	grammatical
sober	dirty	cloudy	serious	fitting
droll	delightful	odd	forceful	foreign
stately	dignified	thin	digestible	valid
disreputable	shameful	forensic	horticultural	susceptible
genteel	wealthy	urban	polite	ignorant
original	oral	derelict	first	reliable
novel	expensive	new	gloomy	radical
famous	celebrated	faithful	renewed	nimble
systematic	laudatory	orderly	jubilant	ambitious
fatigued	pliable	grave	weary	fanatic

resplendent	phonetic	tart	brilliant	fearless
generous	oblivious	ardent	liberal	defiant
kingly	bland	facial	recent	regal
flexible	pitiable	formal	pliant	peaceful
sagacious	exotic	apparent	wise	mild
heedless	patient	eligible	parallel	rash
deficient	constant	dreary	lacking	peculiar
vigilant	watchful	indulgent	valorous	nascent
minimum	humid	restricted	tranquil	least
gallant	chivalrous	authentic	treacherous	probable
giddy	feminine	casual	dizzy	comical
discreet	caustic	redolent	honorable	prudent
destined	simplified	fated	directional	lucky
eternal	momentous	benign	priceless	perpetual
lavish	combined	ribald	worthy	extravagant
defective	concealed	mythical	faulty	external
vague	numb	obscure	indecent	vermiculate
essential	classical	indispensable	deplorable	candid
impulsive	impetuous	petrified	immature	compulsory
diffident	fabulous	shy	valuable	alphabetical
erroneous	solemn	false	ironic	tragic
benevolent	kind	native	suitable	modest
grimy	stern	filthy	grim	colorful
lacerated	disgruntled	mangled	fringed	stricken
insolent	studious	envious	arrogant	accidental

STOP HERE

S

COMPLETION

Mark the first letter of the word which fits the definition.

NAME _____

The wife of a king.
F ..... N ..... P ..... Q ..... V .....

The headpiece in armor.
D ..... H ..... K ..... P ..... T .....

A song to quiet babies.
D ..... F ..... G ..... K ..... L .....

A keen-edged instrument for shaving.
C ..... D ..... H ..... R ..... T .....

A mark to shoot at, as for practice.
F ..... H ..... J ..... R ..... T .....

A short sleep or doze.
B ..... F ..... K ..... N ..... P .....

A war ax used by North American Indians.
C ..... K ..... N ..... T ..... V .....

A box or room for keeping food cool.
D ..... H ..... N ..... Q ..... R .....

A dealer in foodstuffs.
A ..... E ..... G ..... L ..... N .....

The metal tube of a gun.
B ..... F ..... N ..... P ..... U .....

A ticket used in voting.
B ..... N ..... P ..... W ..... Y .....

A piece of cloth sewed on a garment to mend it.
F ..... H ..... J ..... N ..... P .....

The price of transportation for a person.
B ..... F ..... H ..... J ..... K .....

A sack or pouch for holding something.
B ..... F ..... L ..... N ..... W .....

The art of shooting with bows and arrows.
A ..... B ..... I ..... L ..... R .....

An enclosure containing fruit trees.
B ..... E ..... F ..... O ..... R .....

A mark remaining after a wound is healed.
F ..... J ..... N ..... S ..... V .....

A strip of material used in dressing wounds.
A ..... B ..... E ..... F ..... H .....

A magnetic instrument for determining direction.
B ..... C ..... G ..... L ..... N .....

A liquid used in rinsing the throat.
G ..... J ..... K ..... Q ..... T .....

A lure to catch fish or other animals.
B ..... G ..... H ..... M ..... V .....

A very strong wire rope.
A ..... C ..... F ..... K ..... P .....

A large swallow, a mouthful.
C ..... D ..... E ..... G ..... N .....

A trembling of the earth's surface.
C ..... E ..... G ..... I ..... P .....

A house for a dog.
E ..... G ..... H ..... J ..... K .....

A window in a roof.
F ..... H ..... J ..... R ..... S .....

A short brisk leap, especially on one foot.
D ..... H ..... O ..... P ..... T .....

The part of the day between noon and evening.
A ..... B ..... C ..... E ..... F .....

A place where money is coined.
J ..... K ..... L ..... M ..... N .....

A window above a door or another window.
G ..... J ..... L ..... Q ..... T .....

The horn of a deer.
A ..... D ..... F ..... K ..... U .....

One who habitually asks for charity.
B ..... J ..... N ..... Q ..... U .....

One who works in stone.
D ..... J ..... M ..... R ..... Y .....

A musical composition for two performers.
C ..... D ..... F ..... N ..... S .....

A field on which grass is grown for hay.
J ..... K ..... M ..... N ..... R .....

A tenth part of a cent.
K ..... L ..... M ..... N ..... O .....

The coat of wool that covers a sheep.
D ..... F ..... G ..... K ..... M .....

A frame to hold a painter's canvas upright.
B ..... E ..... G ..... I ..... L .....

Love of one's country.
H ..... K ..... P ..... S ..... W .....

The lading or freight of a ship.
C ..... D ..... E ..... H ..... I .....

The very hard outer layer of teeth.
A ..... B ..... E ..... F ..... G .....

A liquid for drinking.
B ..... F ..... H ..... Q ..... U .....

In each row of five words below, mark the word which means the same as the first word in that row.

moist	curt	humane	damp	moderate
quick	major	hasty	narrow	vigorous
annual	variable	yearly	listless	untenable
splendid	expansive	gay	rigid	excellent
customary	nocturnal	radial	prime	usual
fluid	livid	dead	liquid	talkative
idle	lazy	cross	wild	useful
deserted	drab	absurd	disturbed	abandoned
rare	holy	crass	infrequent	weak
contented	nasty	continuous	defamatory	satisfied
enraged	pleasing	poor	angry	domestic
beneficial	artificial	tamable	helpful	piquant
moldy	tonic	musty	shapeless	mute
rasping	harsh	minute	kinaesthetic	marshy
dietary	diagrammatic	amorphous	dietetic	grammatical
sober	dirty	cloudy	serious	fitting
droll	delightful	odd	forceful	foreign
stately	dignified	thin	digestible	valid
disreputable	shameful	forensic	horticultural	susceptible
genteel	wealthy	urban	polite	ignorant
original	oral	derelict	first	reliable
novel	expensive	new	gloomy	radical
famous	celebrated	faithful	renewed	nimble
systematic	laudatory	orderly	jubilant	ambitious
fatigued	pliable	grave	weary	fanatic

resplendent	phonetic	tart	brilliant	fearless
generous	oblivious	ardent	liberal	defiant
kingly	bland	facial	recent	regal
flexible	pitiable	formal	pliant	peaceful
sagacious	exotic	apparent	wise	mild
heedless	patient	eligible	parallel	rash
deficient	constant	dreary	lacking	peculiar
vigilant	watchful	indulgent	valorous	nascent
minimum	humid	restricted	tranquil	least
gallant	chivalrous	authentic	treacherous	probable
giddy	feminine	casual	dizzy	comical
discreet	caustic	redolent	honorable	prudent
destined	simplified	fated	directional	lucky
eternal	momentous	benign	priceless	perpetual
lavish	combined	ribald	worthy	extravagant
defective	concealed	mythical	faulty	external
vague	numb	obscure	indecent	vermiculate
essential	classical	indispensable	deplorable	candid
impulsive	impetuous	petrified	immature	compulsory
diffident	fabulous	shy	valuable	alphabetical
erroneous	solemn	false	ironic	tragic
benevolent	kind	native	suitable	modest
grimy	stern	filthy	grim	colorful
lacerated	disgruntled	mangled	fringed	stricken
insolent	studious	envious	arrogant	accidental

NAME..... S

THE AMERICAN COUNCIL ON EDUCATION

THE CHICAGO TESTS OF PRIMARY MENTAL ABILITIES

For Ages 11 to 17

Prepared by

L. L. THURSTONE, The University of Chicago

and

THELMA GWINN THURSTONE, The Chicago Teachers College

with the cooperation of

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Published by
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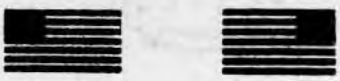
744 Jackson Place, Washington, D. C.

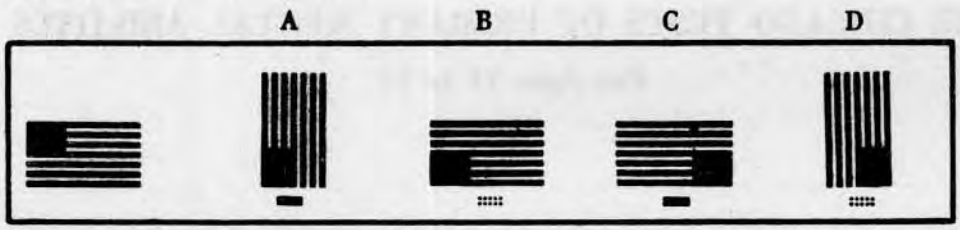
FLAGS

The two flags below are alike. You can slide one around on the page to fit the other exactly.

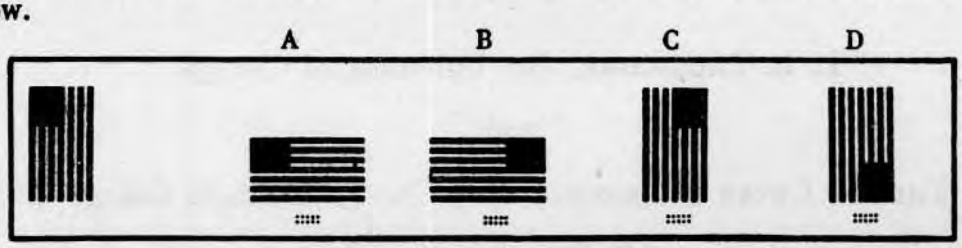
Now look at the next two flags. They are different. You cannot make them fit by sliding them around on the page.



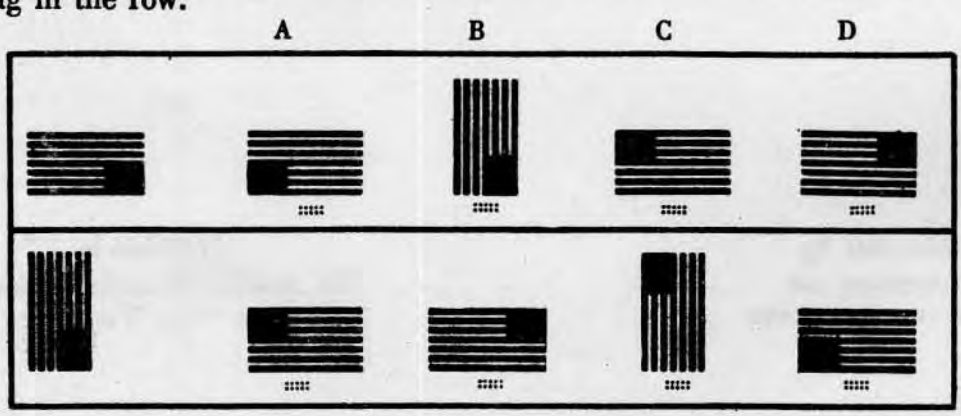
Here are more flags. Some of the flags are marked. The flags that are **like** the first flag in this row are marked.



Below is another row of flags. Mark all the flags that are **like** the first flag in the row.



You should have marked the flags B and D.
Here are more flags for you to mark. In each row mark every flag that is **like** the first flag in the row.



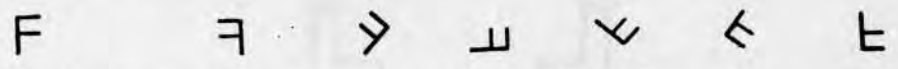
Stop here. Wait for further instructions from the examiner.

FIGURES

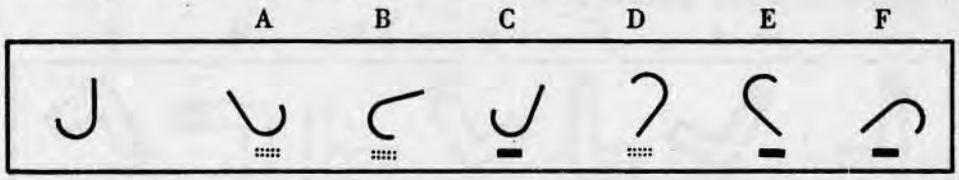
Look at the row of figures below. The first figure is like the letter **F** which is right side up. All the other figures are like the first but they have been turned in different directions.

Satisfy yourself that all of these figures look like the first one if they are turned right side up.

Now look at the next row of figures. The first one looks like an **F**. But none of the other figures would look like an **F** even if they were turned right side up. They are all made backward.

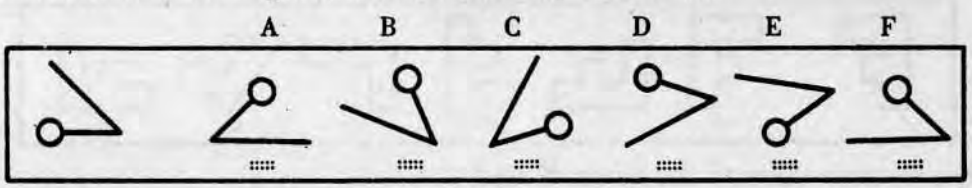


Some of the figures in the next row are like the first figure. Some are made backward. The figures like the first figure are marked.



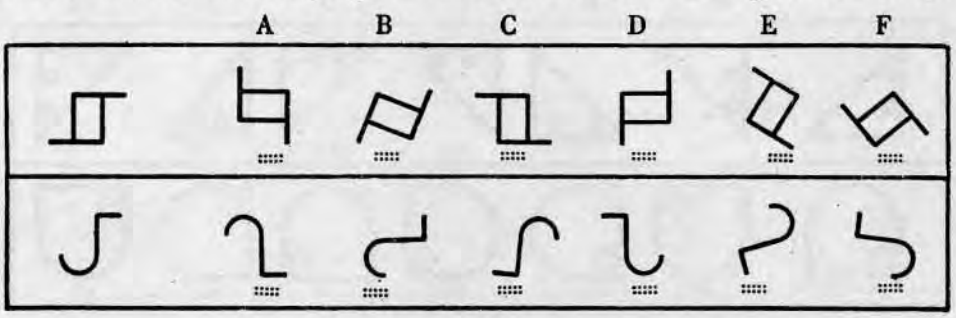
Notice that all the figures like the first figure are marked.

In the row of figures below, mark every figure which is **like** the first figure in the row. Do not mark the figures which are made backward.



You should have marked the figures A and E.

In each row below mark every figure which is **like** the first figure in the row.



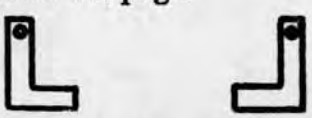
Stop here. Wait for further instructions from the examiner.

CARDS

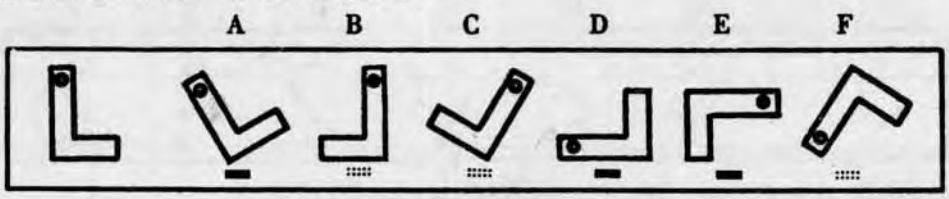
Here is a picture of a card. It looks like an **L**, and it has a hole in one end.

The two cards below are alike. You can slide one around on the page to fit the other exactly.

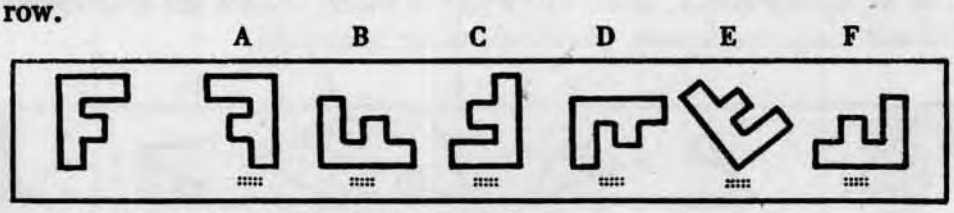
Now look at the next two cards. They are different. You cannot make them fit exactly by sliding them around on the page.



Here are more cards. Some of the cards are marked. The cards which are like the first card in this row are marked.

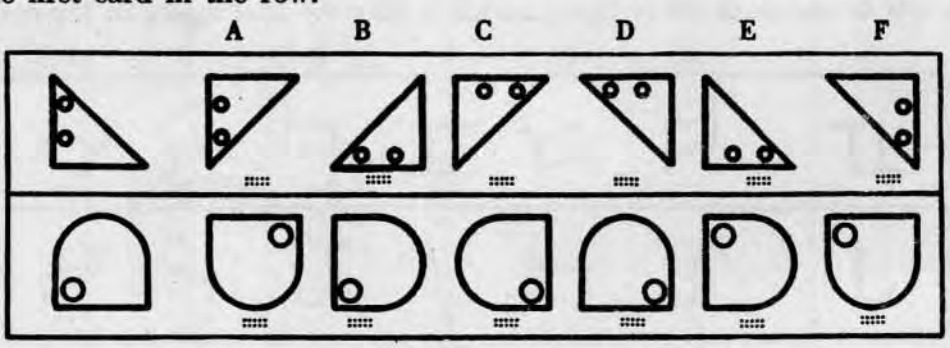


Below is another row of cards. Mark all the cards which are **like** the first card in the row.

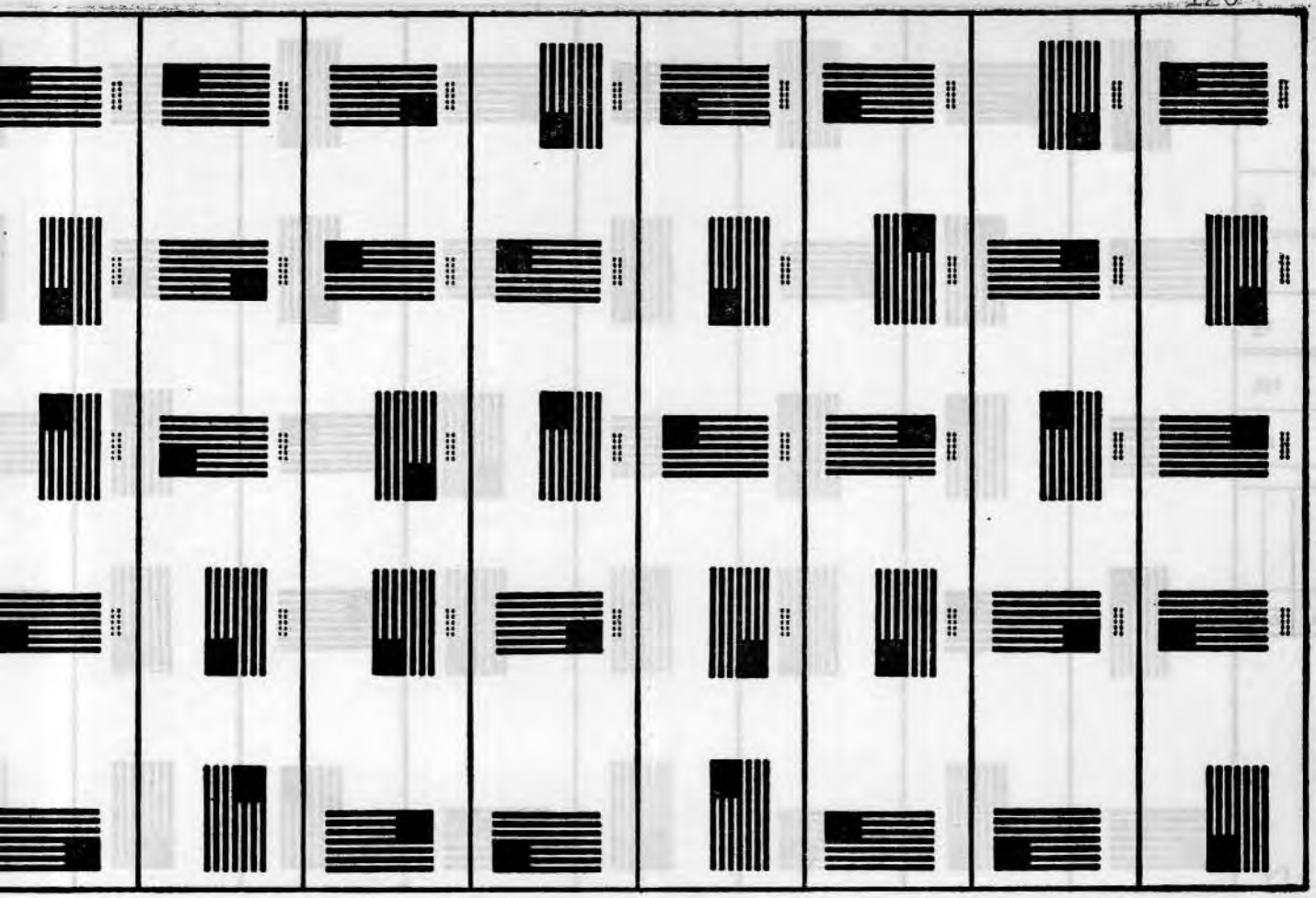


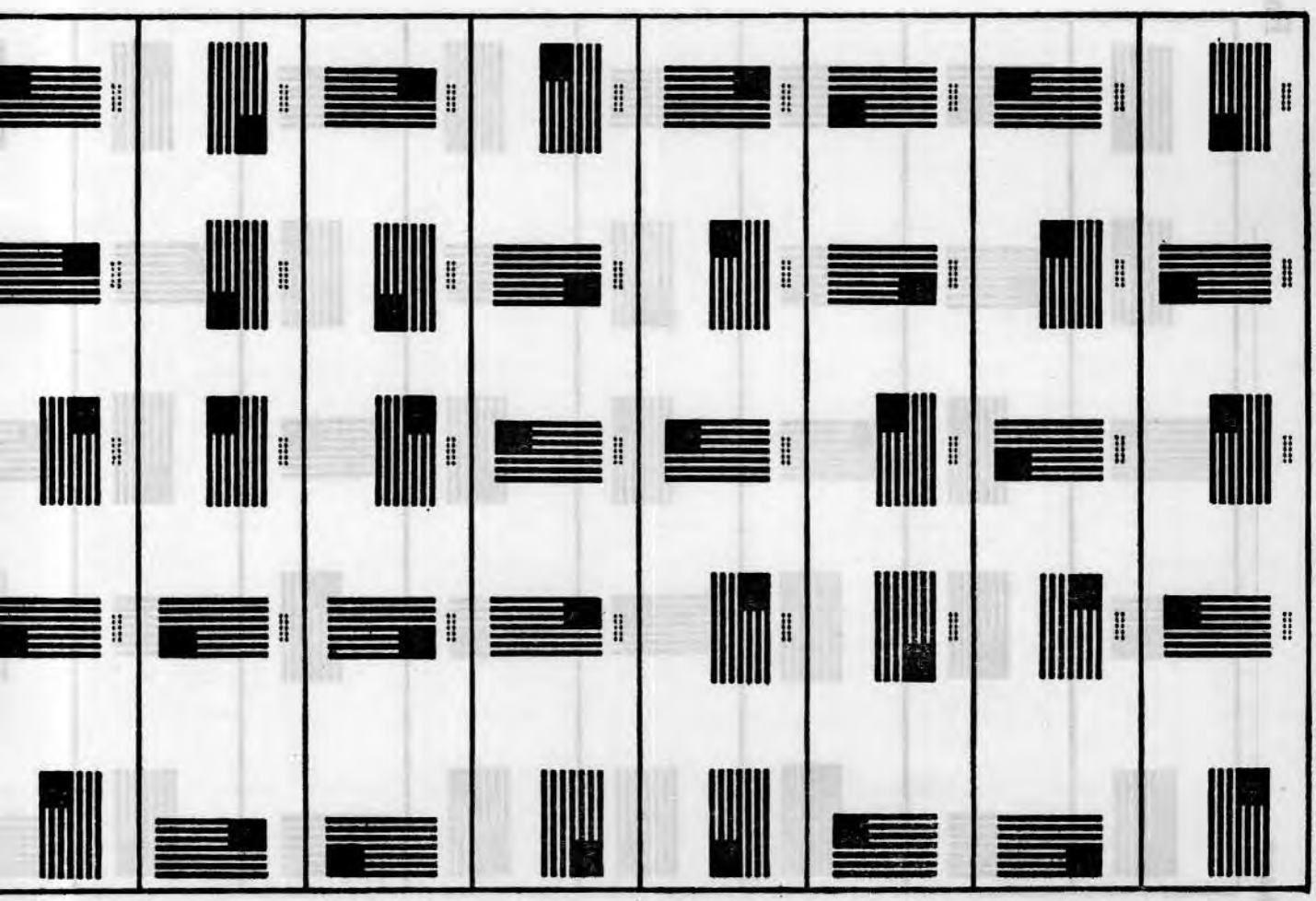
You should have marked the cards B and C.

Here are some more cards for you to mark. In each row mark every card that is **like** the first card in the row.



Stop here. Wait for further instructions from the examiner.

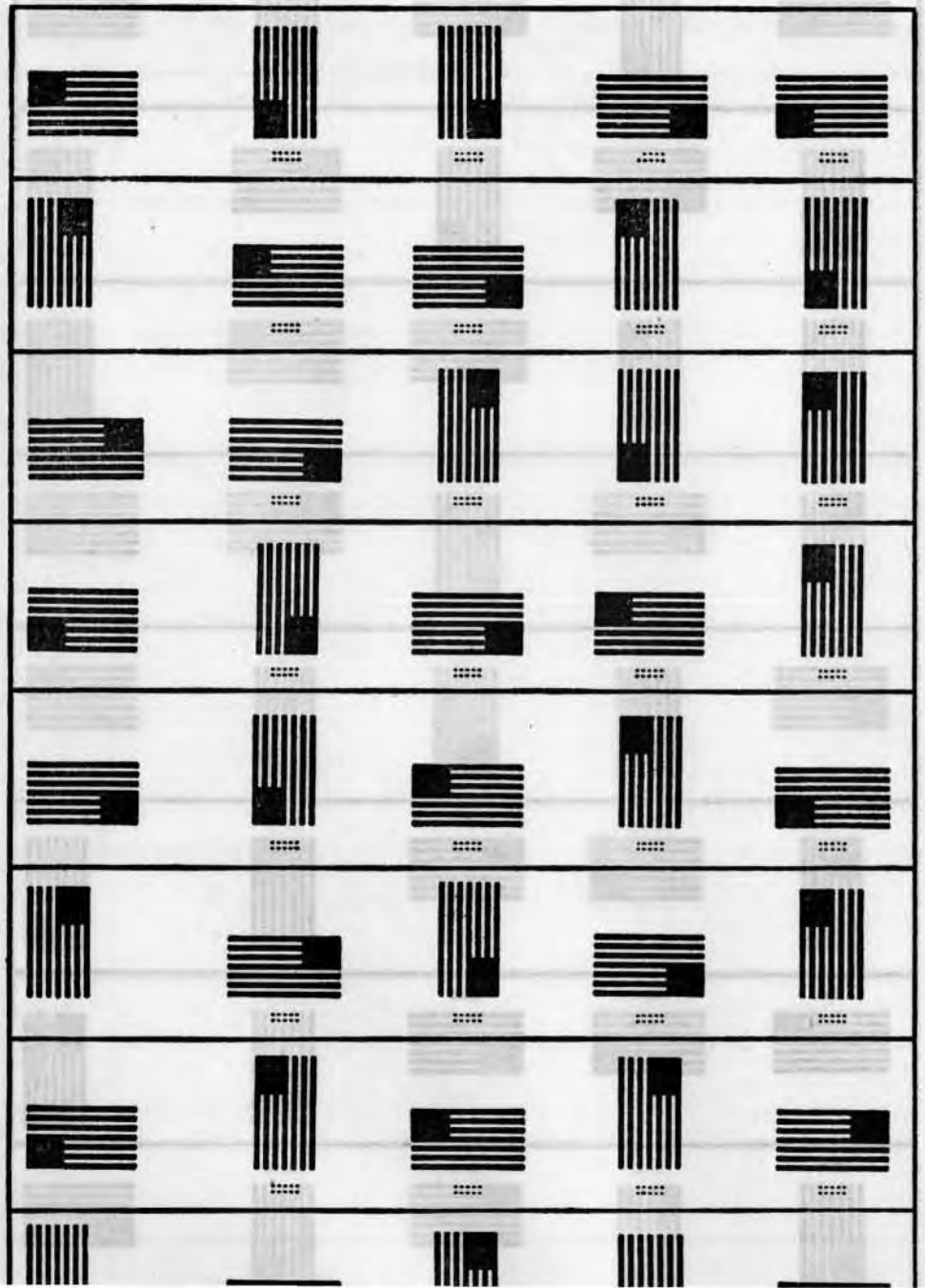


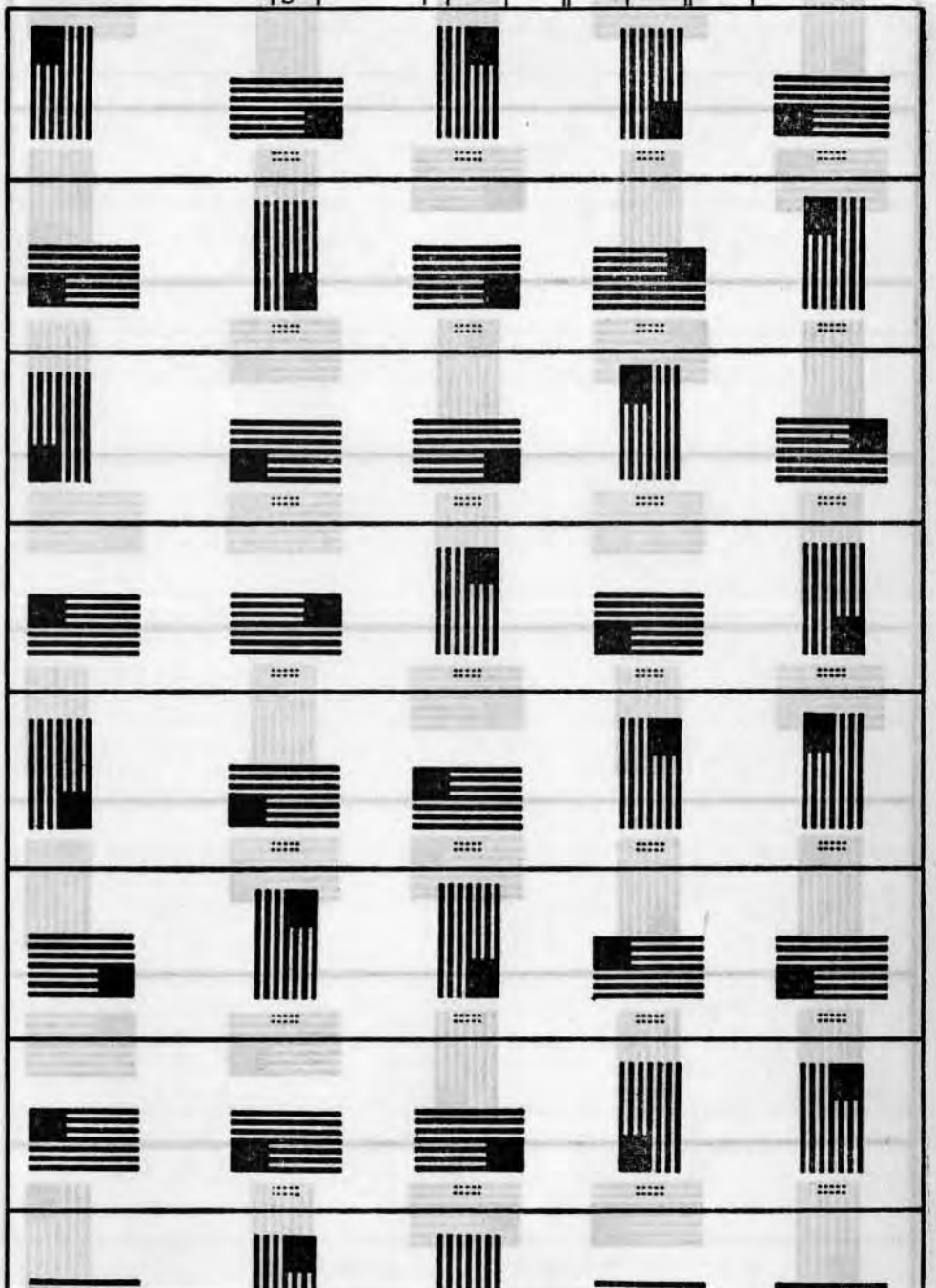


NAME _____

S_2	
S_1	
S	

R_2	W_2	S_2	S_1	S





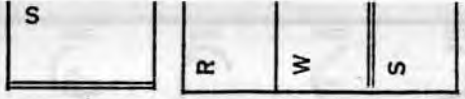
which is like the first figure in the row.

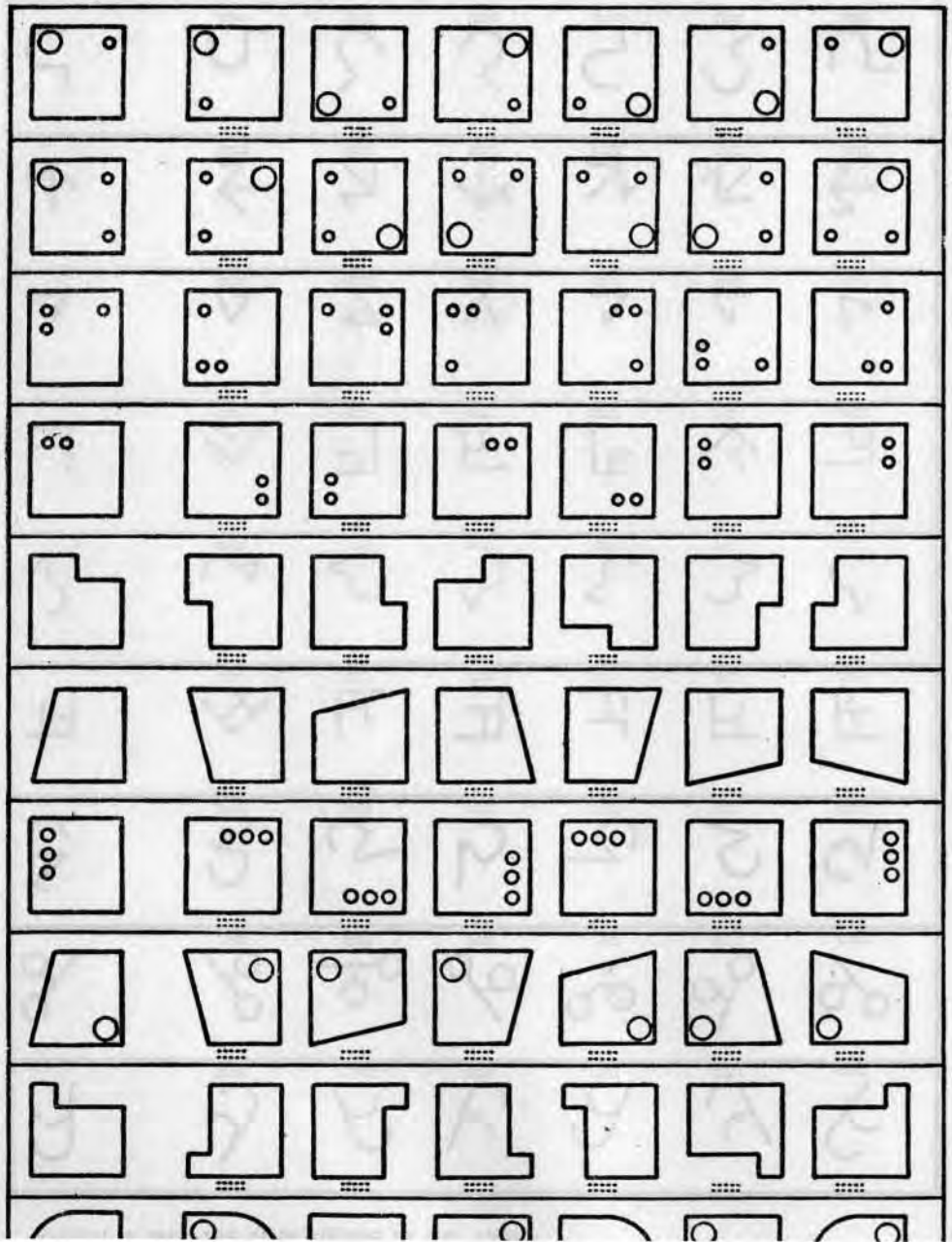
STOP HERE.

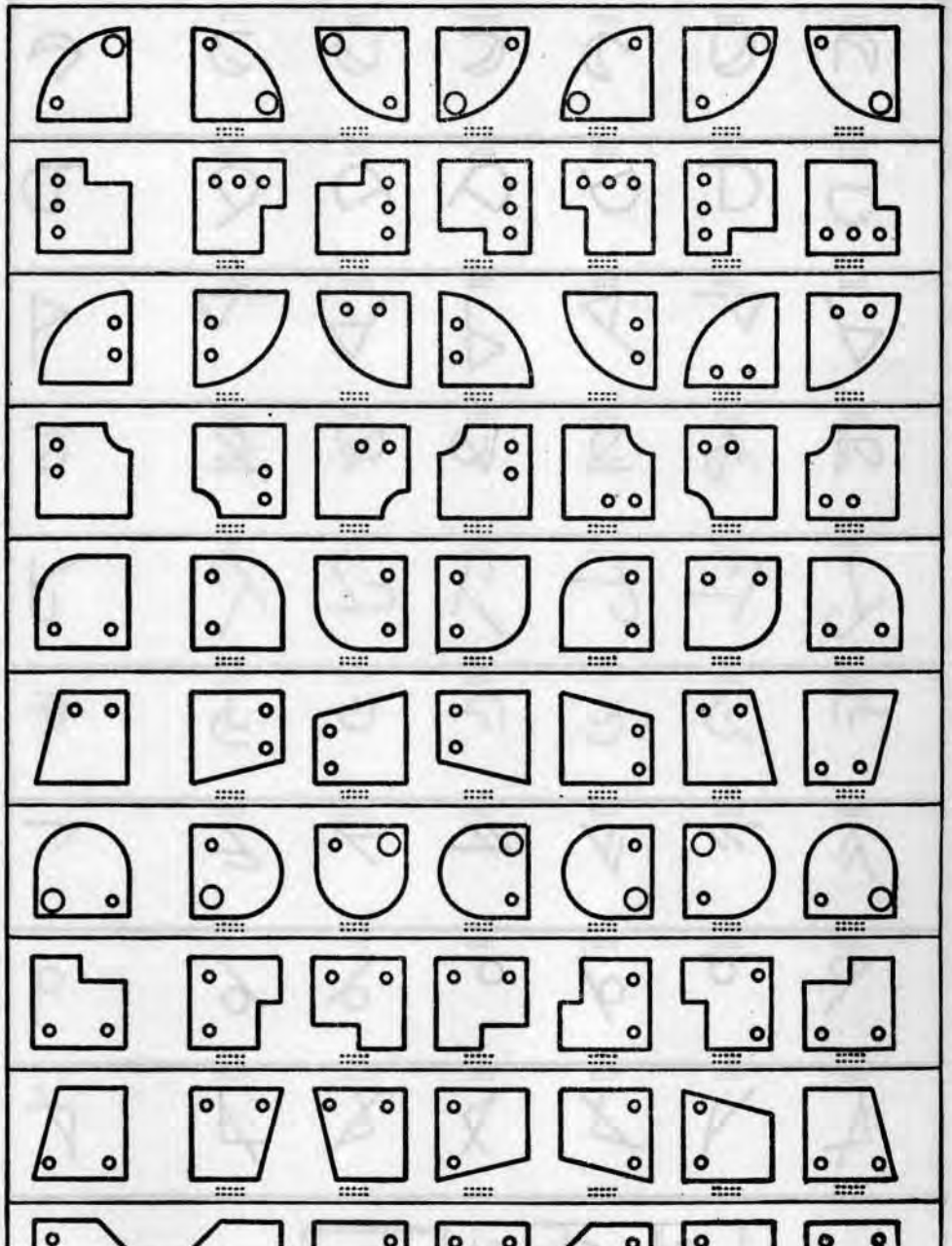
CARDS

In each row mark every card that is like the first card in the row.

NAME_____







NAME..... **W**

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	Score
First Letters	
Four-Letter Words	
Suffixes	
Composite Score in **W**	

Published by
The American Council on Education
744 Jackson Place, Washington, D. C.

FIRST LETTERS

Name.....

Look at the words in the following list. Each word **begins** with **D.**

doll

dinner

daisy

doughnut

On the blanks below write several words which **begin** with **P.** One word you might write is **pretty.** Go ahead and write more words which **begin** with **P.**

When the signal is given (not yet), turn the page. You will be given a **new letter.** Write as many words as you can which begin with the new letter. Write the words as fast as you can.

Stop here. Wait for the signal.

SCORE

FIRST LETTERS

The new letter is **S.**

Write as many words as you can which **begin** with **S.**

1.	21.	41.	61.
2.	22.	42.	62.
3.	23.	43.	63.
4.	24.	44.	64.
5.	25.	45.	65.
6.	26.	46.	66.
7.	27.	47.	67.
8.	28.	48.	68.
9.	29.	49.	69.
10.	30.	50.	70.
11.	31.	51.	71.
12.	32.	52.	72.
13.	33.	53.	73.
14.	34.	54.	74.
15.	35.	55.	75.
16.	36.	56.	76.
17.	37.	57.	77.
18.	38.	58.	78.
19.	39.	59.	79.
20.	40.	60.	80.

Stop h

FOUR-LETTER WORDS

Name.....

Look at the words in the following list. Each word has **four** letters and **begins** with **B.**

bear

bone

bold

bent

On the blanks below write several **four-letter** words which **begin** with **M.** One word you might write is **most.** Go ahead and write more **four-letter** words which **begin** with **M.**

When the signal is given (not yet), turn the page. You will be given a **new letter.** Write as many four-letter words as you can which begin with the new letter. Write the words as fast as you can.

Stop here. Wait for the signal.

SUFFIXES

Name.....

Look at the words in the following list. Each word **ends** with **est.**

finest

coldest

nearest

softest

On the blanks below write several words which **end** with **ness.** One word you might write is **kindness.** Go ahead and write more words which **end** with **ness.**

When the signal is given (not yet), turn the page. You will be given some **new letters.** Write as many words as you can which end with the new letters. Write the words as fast as you can.

Stop here. Wait for the signal.

SCOR

SUFFIXES

The new letters are **tion.**

Write as many words as you can which **end** with **tion.**

1. _____ 21. _____ 41. _____
2. _____ 22. _____ 42. _____
3. _____ 23. _____ 43. _____
4. _____ 24. _____ 44. _____
5. _____ 25. _____ 45. _____
6. _____ 26. _____ 46. _____
7. _____ 27. _____ 47. _____
8. _____ 28. _____ 48. _____
9. _____ 29. _____ 49. _____
10. _____ 30. _____ 50. _____
11. _____ 31. _____ 51. _____
12. _____ 32. _____ 52. _____
13. _____ 33. _____ 53. _____
14. _____ 34. _____ 54. _____
15. _____ 35. _____ 55. _____
16. _____ 36. _____ 56. _____
17. _____ 37. _____ 57. _____
18. _____ 38. _____ 58. _____
19. _____ 39. _____ 59. _____
20. _____ 40. _____ 60. _____

Stop

NAME..... **R** 132

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LETTER SERIES

Study the series of letters below. What letter should come next?

a b a b a b a b — a b c d e f

The next letter in this series should be **a.** The letter **a** has been marked in the answer row at the right.

Now study the next series of letters and decide what the next letter should be. Mark the letter in the answer row at the right.

c a d a e a f a — a c d e f g

You should have marked the letter **g.**

Now study the series of letters below. In each series decide what the next letter should be and mark the letter in the answer row at the right.

c d c d c d — a b c d e f

a a b b c c d d — a b c d e f

a b x c d x e f x g h x — h i j k x y

You should have marked **c, e,** and **i.**

Now work the following problems for practice. Mark the correct letters in the answer rows.

a a a b b b c c c d d — a b c d e f

a x b y a x b y a x b — a b c x y z

a b m c d m e f m g h m — g h i j m n

r s r t r u r v r w r x r — r s t w x y

a b c d a b c e a b c f a b c — a b c f g h

Stop here. Wait for further instructions from the examiner.

LETTER GROUPING

Look at the groups of letters below.

AABC ACAD ACFH AACG

Three of the groups have two **A**'s. The group which does not have two **A**'s is marked.

Here is another problem. Three of the groups are alike in some way. Can you find three groups which are alike? Mark the one that is different.

XURM ABCD MNOP EFGH

In three of the groups the letters are arranged in alphabetical order. The first group is not in alphabetical order. You should have marked it to show that it is different.

Three of the groups in the next row are alike in some way. Mark the group that is different.

KABC KEFG LOPQ KUVW

Three of the groups start with **K.** You should have marked the third group, which is different.

Here is another problem. Mark the group that is different.

BDEF ILMN LNOP QSTU

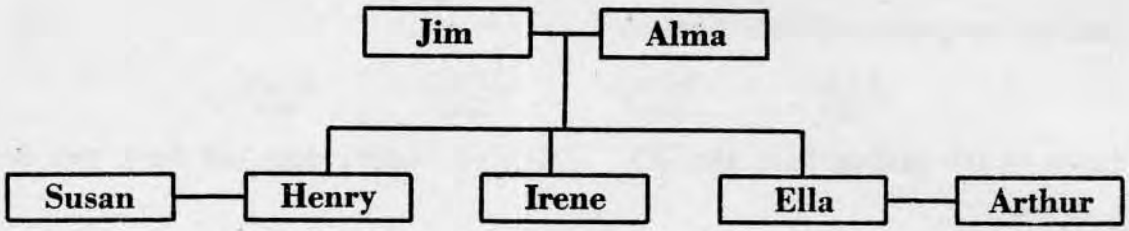
Three of the groups omit only one letter. You should have marked the second group, which is different.

Here are more problems for you to work. In each row three of the groups are alike in some way. Mark the group that is different. Go right ahead.

AAAB	AAAM	AAAR	AATV
DCBA	HGFE	MRUX	PONM
RSTT	LMNL	FGHI	BCDB
ABCE	FGHJ	KLMO	RSTW

Stop here. Wait for further instructions from the examiner.

PEDIGREES



This chart tells you that Jim and Alma were married and had three children, Henry, Irene, and Ella. Henry married a girl named Susan, and Ella married a man named Arthur.

Now answer these questions by consulting the chart.

Irene's brother is

Jim Henry Arthur Ella Susan

How many children has Alma?

1 2 3 4 5

Irene's brother-in-law is

Henry Susan Ella Arthur Jim

Ella's sister-in-law is

Susan Arthur Irene Alma Henry

Jim is Alma's

father husband brother son uncle

Susan is Henry's

wife sister daughter aunt niece

How many daughters has Jim?

0 1 2 3 4

Arthur's mother-in-law is

Ella Irene Susan Alma Jim

Jim's daughter-in-law is

Alma Irene Ella Arthur Susan

Stop here. Wait for further instructions from the examiner.

In each series of letters decide what the next letter should be and mark the letter in the answer row at the right.

a a b c c d e e f g g —	a	b	c	f	g	h
a x a y b x b y c x c y d x d —	d	e	f	x	y	z
a b c a b c d e f d e f g h i —	g	h	i	j	k	l
a b c x y z d e f x y z g h i —	j	k	l	x	y	z
a b c a b d a b e a b f —	a	b	c	f	g	h
x y z a x y z b x y z c x y z —	x	b	c	d	e	y
e f c g h c i j c k l c m n c —	c	d	m	n	o	p
c b a c b a c b a c b —	a	b	c	d	e	f
a m b c m d e f m g h i j —	h	i	j	k	l	m
a a c c e e g g i i —	h	i	j	k	l	m
e f e f c d g h g h c d i j —	c	d	i	j	k	l
a b b c c c d d d d e e e e —	d	e	f	g	h	i
a b c a b c d a b c d e —	a	b	c	d	e	f
a b c c d e f f g h i i j k l —	j	k	l	m	n	o
a b a c d c e f e g h g i j —	g	h	i	j	k	l

a b c n o d e f n o g h i n o —	i	j	k	n	o	p
a b b b c d d d e f f f g h h —	g	h	i	j	k	l
h g f e d c b —	a	b	c	g	h	i
a c e g i k m —	j	k	l	m	n	o
a x b y c z a x b y c z a x b —	a	b	c	x	y	z
a b b c d d e f f g h —	e	f	g	h	i	j
g h j k m n p q s t v w —	u	v	w	x	y	z
a b c a d e f d g h i g j k l —	i	j	k	l	m	n
a s b t c u d v e w f x g —	f	g	h	x	y	z
a a b b c d d e e f g g h —	h	i	j	k	l	m
a a b a b c c d c d e e f —	e	f	g	h	i	j
a c f h k m p r —	p	q	r	s	t	u
v v v v v w w w w x x x y —	u	v	w	x	y	z
a b c c b a d e f f e d g h i —	h	i	j	k	l	m
a b c b c d e f e f g h i h —	f	g	h	i	j	k

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S

LETTER GROUPING

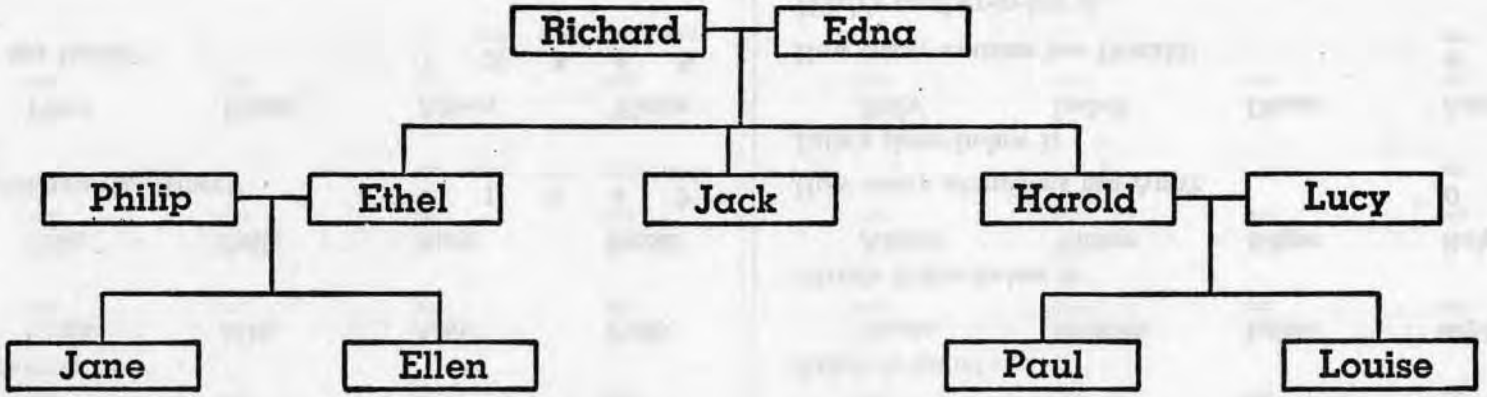
In each row three of the groups of letters are alike in some way. Mark the one that is different.

NAME _____

AAAM	AACA	AAAD	AAAK
ABCD	EFGH	IJKL	OPST
BXYC	FPQG	JXYK	LXYM
DFDF	KLKL	STVW	BCBC
ABCP	CBAQ	ABCR	ABCS
DCCJ	DBBJ	DNNJ	DRSJ
CXYZ	CFGH	DPQR	CLMN
BEFE	HIJI	NOPO	TUVU
BCDD	FFGH	JKLL	PQRR
KLMN	BCDE	FGHE	RSTE
CBAL	BCAL	CFBA	BCLA
UVWU	ABCA	IJKI	FGHG
PQRS	MLKJ	NMLK	ZYXW
DAJA	DUJU	DEJN	DIJI

BCCD	FGHH	JKKL	PQQR
MNOP	DEFG	GIKL	STUV
BCBD	FGFH	LMLN	PQPX
AEIK	AKIE	IOKU	EIAK
ABDE	FGJK	LMOP	QRTU
DABC	HEFG	MIJK	ROPQ
AMBN	CWDP	EQFR	GSHT
ABDC	EFHG	IJMK	OPRQ
RSAC	TUXY	MNEF	HILM
ARSB	CTUD	EVWG	JOPK
NNOP	QRSS	TTUV	WWXY
PXAM	SPCD	DXMF	SAMY
MBAN	ODCP	QFER	SGHT
MLLM	DCCD	RSSR	HGGH

Consult the chart for the answers to the questions below.



How many nephews has Harold? 0 1 2 3 4

Jane's sister is
Lucy Ellen Edna Ethel Louise

Jack is Louise's
brother husband son nephew uncle

Jack's brother-in-law is
Philip Lucy Harold Paul Richard

How many children has Harold? 0 1 2 3 4

Richard's daughter is
Ellen Jane Ethel Edna Louise

How many uncles has Jane? 0 1 2 3 4

Lucy's son is
Richard Paul Jack Harold Louise

Paul's aunt is
Jane Ethel Ellen Edna Lucy

Jack's nephew is
Harold Philip Jane Paul Richard

How many grandchildren has Richard? 1 2 3 4 9

Ellen is Harold's
niece daughter wife aunt mother

Ethel is Louise's
mother niece cousin sister aunt

Harold married
Edna Lucy Ethel Ellen Louise

How many nieces has Jack? 3 4 7 8 9

Jack is Ethel's
uncle cousin nephew son brother

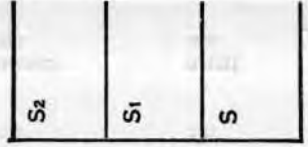
Does Ellen have a brother? Yes No

Lucy's sister-in-law is
Jane Ethel Ellen Louise Edna

Edna's grandson is
Harold Ellen Jack Richard Paul

Louise is Paul's
sister niece aunt cousin mother

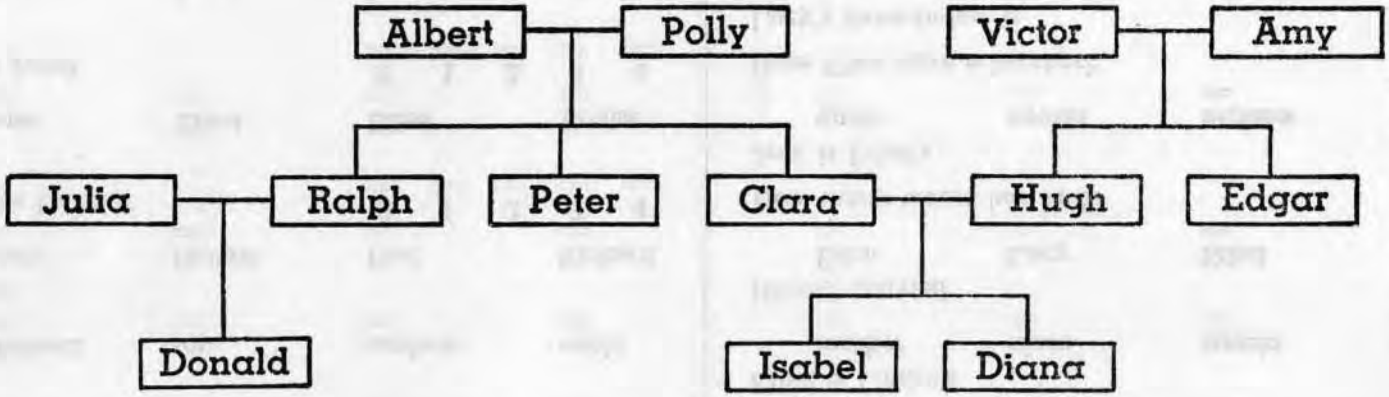
TURN THE PAGE. GO RIGHT AHEAD.



PEDIGREES

Consult the chart for the answers to the questions below.

NAME _____



Peter's brother is
Victor Hugh Donald Ralph Albert

Clara is Donald's
mother aunt niece cousin sister

Donald's grandmother is
Diana Clara Julia Amy Polly

Diana's mother is
Clara Julia Polly Amy Isabel

How many grandchildren has Albert?
0 1 3 6 9

Hugh's brother is
Ralph Peter Edgar Albert Victor

How many uncles has Isabel?
1 2 3 4 5

Clara is Peter's
wife sister aunt niece daughter

Polly's daughter is
Julia Clara Amy Isabel Diana

Albert's daughter-in-law is
Clara Polly Isabel Amy Julia

Hugh is Edgar's
brother cousin nephew father uncle

Ralph is Isabel's
cousin brother father nephew uncle

Clara's father-in-law is
Albert Victor Edgar Ralph Hugh

How many grandsons has Amy?
0 1 2 3 4

Julia's sister-in-law is
Polly Isabel Diana Amy Clara

How many cousins has Donald?
0 1 2 3 6

Hugh's mother-in-law is
Julia Polly Isabel Diana Amy

Donald's grandfather is
Peter Edgar Hugh Victor Albert

NAME..... 137

M

THE AMERICAN COUNCIL ON EDUCATION

THE CHICAGO TESTS OF PRIMARY MENTAL ABILITIES

For Ages 11 to 17

Prepared by
L. L. THURSTONE, The University of Chicago
and
THELMA GWINN THURSTONE, The Chicago Teachers College
with the cooperation of
The Bureau of Child Study of the Chicago Public Schools

FIRST NAMES

In the first row the correct first name has been marked. Mark the correct first name for each last name. Mark only one name in each row. Go right ahead.

Last Name	First Name				
Preston	Fred	John	Mary	Nancy	**Ruth**
Brown	John	Mary	Nancy	Ruth	Walter
Smith	Fred	John	Mary	Nancy	Walter
Davis	Fred	John	Nancy	Ruth	Walter

Stop here. Wait for further instructions from the examiner.

Published by
The American Council on Education
744 Jackson Place, Washington, D. C.

WORD-NUMBER

In the first row of numbers, 21 is marked because 21 is the number of **chair.**

Mark the number of each of the other words. Mark one number in each row. Go right ahead.

chair	18	21	31	41	43
lamp	17	37	44	73	88
box	21	35	44	66	77
fan	21	35	66	77	92

Stop here. Wait for further instructions from the examiner.

In each row below mark the correct first name.
Mark only one name in each row.

NAME _____

LAST NAME	FIRST NAME						
Lynn	Charles	Dorothy	Edith	Frank	Harry	Helen	Howard
Harvey	Charles	David	Dorothy	Edith	Lillian	Louise	Robert
Carson	George	Harry	Hazel	Helen	Howard	Jane	Louise
Thompson	Charles	Dorothy	Edith	Frank	Helen	James	Lena
Johnson	Alice	Edward	George	Hazel	Jane	Lillian	Louise
Richards	David	Edward	George	Hazel	James	Lena	Lillian
Morrison	David	Edith	Edward	George	Helen	James	William
King	Charles	Dorothy	Frank	Harry	Howard	Lena	Lillian
Nelson	Dorothy	Edith	Frank	Harry	Helen	Lena	Louise
Gray	David	Edward	George	Hazel	James	Jane	Louise
Wilson	Alice	Ann	Hazel	Howard	James	Jane	Lillian
Palmer	Dorothy	Edward	Edith	George	Harry	Helen	James
Webster	Ann	David	Frank	Howard	Lena	William	Robert
Mitchell	Alice	Edith	Harry	Hazel	Helen	James	Jane
Jones	Ann	Charles	David	Dorothy	Frank	Robert	William
Perry	Edith	Edward	Frank	Hazel	James	Jane	Lillian
Stewart	Dorothy	George	Harry	Helen	Howard	Lena	Louise
Adams	Ann	David	Dorothy	Edith	Frank	James	Lillian
Wright	Edward	George	Harry	Hazel	Helen	Jane	Lena
Irwin	Ann	David	Dorothy	Edward	Frank	Lillian	Robert

WORD-NUMBER

S

In each row below mark the correct number of the word.
Mark only one number in each row.

fence	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
desk	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
ball	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
door	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
hat	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
coat	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
stool	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
purse	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
dish	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
post	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
rug	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
glass	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
pan	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
match	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
book	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83
rope	57	58	59	61	62	63	64	67	68	69	71	72	73	74	76	78	79	81	82	83

STOP HERE.

APPENDIX B

CALCULATIONS RELATED TO THE TOTAL GROUP

TABLES FOR COMPUTING MEDIANS

No.	SUBJECT	CENTILE SCORE		SUBJECT	CENTILE SCORE		SUBJECT	CENTILE SCORE	SUBJECT	CENTILE SCORE	
	FACTOR	NUMBER			VERBAL			SPATIAL		WORD	
1	HH	77		AR	47		HE	99	NG	58	1
2	GR	70		HJ	33		LJ	91	HH	52	2
3	HJ	63		NG	33		DT	89	HJ	38	3
4	BH	61		HH	32		NA	89	PA	27	4
5	AW	49		RR	24		SG	80	AR	27	5
6	AZ	40		GE	20		VJ	76	GR	27	6
7	LJ	39		SG	20		KD	75	ZR	20	7
8	VJ	37		PA	18		HJ	75	NA	14	8
9	BF	36		MW	16		GF	67	MW	13	9
10	BHa	33		GF	15		HH	64	VJ	13	10
11	AR	31		VJ	14		BH	63	AZ	11	11
12	KD	31		KT	12		AW	52	BG	10	12
13	MW	30		BH	11		NG	49	GE	09	13
14	HE	26		GR	10		BHa	48	BF	08	14
15	SG	26		LW	08		LW	44	BHa	08	15
16	PG	24	mdn	PG	08	mdn	GR	43	BH	08	16
17	PA	23		NA	07		ZR	41	RR	07	17
18	RM	21		AZ	06		AR	41	GF	06	18
19	GE	20		BF	04		AZ	37	SG	06	19
20	ZR	17		AH	03		PA	35	KT	05	20
21	EM	16		BG	02		RM	34	LW	04	21
22	BG	10		LJ	02		GE	34	LJ	04	22
23	GF	10		DT	01		MW	31	PG	03	23
24	DT	06		ZR	01		KT	22	EM	03	24
25	RR	06		EM	01		PG	20	AW	03	25
26	LW	05		HL	01		HL	18	AH	01	26
27	HL	03		RM	01		AH	11	RM	01	27
28	KT	01		HL	01		EM	03	KD	01	28
29	AH	00.5		KD	01		BF	02	DT	01	29
30	NA	00.5		AW	01		RR	01	HL	00.5	30
31	NG	00.5		BHa	00.5		BG	00.5	HE	00.5	31

TABLES FOR COMPUTING MEDIANS

NO.	SUBJECT FACTOR	CENTILE SCORE REASONING	SUBJECT	CENTILE SCORE MEMORY	NO.
1	LJ	65	PG	66	1
2	HJ	64	ZR	65	2
3	AR	60	HH	33	3
4	EM	39	MW	52	4
5	PG	36	GF	48	5
6	DT	34	HJ	47	6
7	HH	33	LJ	43	7
8	LW	30	AZ	41	8
9	GF	30	GE	27	9
10	AH	29	BH	26	10
11	SG	28	HE	26	11
12	AZ	25	DT	26	12
13	GR	23	AR	24	13
14	VJ	22	EM	20	14
15	HE	20	RR	18	15
16	KT	19	SG	17	16
17	BF	19	NG	16	17
18	NG	16	RM	15	18
19	RR	14	KD	15	19
20	BH	14	KT	15	20
21	PA	12	GR	15	21
22	AW	11	VJ	12	22
23	GE	11	NA	10	23
24	ZR	09	BF	09	24
25	MW	08	LW	05	25
26	NA	08	PA	05	26
27	HL	06	BG	03	27
28	BHa	06	BHa	03	28
29	KD	06	HL	03	29
30	RM	06	AW	01	30
31	BG	00.5	AH	01	31

NUMBER and VERBAL

S U B J E C T

H.P.-N 238 = $\frac{N}{v} = \frac{238}{135} = 1.76$

H.P.-V 135 = v

Dev Σ=56059.47
From N=1808.37
Mean σ=42.52

Σ -233
M -7.52

Vx1.76

	N	V	V^1	N-V^1	X	X^2
AZ	87	45	79	+ 8	15.52	240.87
AH	3	37	65	- 62	54.48	2968.07
AR	81	79	139	- 58	50.48	2548.23
AW	105	21	37	+ 68	75.52	5703.27
BG	61	32	56	+ 5	12.52	156.75
BF	83	33	58	+ 25	32.52	1057.55
BH	103	46	81	+ 22	29.52	871.43
BHa	81	9	16	+ 65	72.52	5259.15
DT	54	32	56	- 2	5.52	30.47
EM	72	23	41	+ 31	38.52	1483.80
GE	77	65	114	- 37	29.48	869.36
GF	58	51	90	- 32	24.48	599.27
GR	111	40	70	+ 41	48.52	2354.19
HJ	97	61	107	- 10	2.48	6.15
HE	75	20	35	+ 40	47.52	2258.15
HH	119	67	118	+ 1	8.52	72.59
HL	39	20	35	+ 4	11.52	132.71
KT	25	48	84	- 59	51.48	2650.19
KD	78	23	40	+ 38	45.52	2072.07
LJ	88	34	60	+ 28	35.52	1155.11
LW	47	47	83	- 36	28.48	811.11
MW	79	56	99	- 20	12.48	155.75
NA	15	57	100	- 85	77.48	6003.15
NG	12	73	128	- 116	108.48	11167.91
PG	83	51	90	- 7	.52	.27
PA	73	60	106	- 33	25.48	649.23
RR	40	52	92	- 52	44.48	1978.47
RM	81	32	56	+ 25	32.52	1057.55
SG	79	66	116	- 37	29.48	869.07
VJ	87	55	97	- 10	2.48	6.15
ZR	70	27	48	+ 22	29.52	871.43

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$\sigma_M = \frac{42.52}{\sqrt{31-1}} = \frac{52.52}{30} = \frac{42.52}{5.48}$$

$$\sigma_M = 7.80$$

$$t = \frac{M_1 - M_2}{\sigma_M}$$

$$\frac{7.52}{7.80}$$

$$t = 96$$

significant at the 50% level

NUMBER AND SPATIAL

S
U
B
J
E
C
T

$\Sigma = 1006$
$M = 32.45$

Sx142

$\Sigma = 88486.60$
$\div N = 2854.41$
$\sigma = 53.43$

	S	S^1	N	$S^1 - N$	X	X^2
AZ	66	94	87	+ 7	25.45	647.70
AH	35	50	3	+ 47	14.55	211.70
AR	68	97	81	+ 16	16.45	270.60
AW	83	118	105	+ 13	19.45	378.30
BG	1	1	61	- 60	92.45	8547.00
BF	7	10	83	- 73	105.45	11119.70
BH	83	118	103	+ 15	17.45	304.50
BHa	71	101	81	+ 20	12.45	155.00
DT	131	186	54	+132	99.55	9910.20
EM	21	30	72	- 42	74.45	5542.80
GE	68	97	77	+ 20	12.45	155.00
GF	86	122	58	+ 64	31.55	995.40
GR	65	92	111	- 19	51.45	2647.10
HJ	91	129	97	+ 32	.45	.20
HE	143	203	75	+128	95.55	9129.80
HH	84	119	119	0	32.45	1053.00
HL	47	67	39	+ 28	4.45	19.80
KT	49	70	25	+ 45	12.55	157.50
KD	95	135	78	+ 57	24.55	602.70
LJ	126	179	88	+ 91	58.55	3428.10
LW	69	98	47	+ 51	18.55	344.10
MW	61	87	79	+ 8	24.45	597.80
NA	129	183	15	+168	135.55	18373.80
NG	76	108	12	+106	73.55	5409.60
PG	52	74	83	- 9	23.45	549.90
PA	64	91	73	+ 18	14.45	208.80
RR	4	6	40	- 34	66.45	4415.60
RM	68	97	81	+ 16	16.45	270.60
SG	107	152	79	+ 73	46.55	2166.90
VJ	101	143	87	+ 56	29.55	873.20
ZR	72	102	70	- 32	.45	.20

$$M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{53.43}{\sqrt{31-1}}$$

$$\sigma_M = 9.76$$

$$t = \frac{M_1 - M_2}{\sigma_M}$$

$$= \frac{32.45}{9.76}$$

$$t = 3.32$$

significant at the 1% level

NUMBER AND WORD

SUBJECT

$\Sigma = 1910$
$M = 61.61$

Dev From Mean $\Sigma = 88{,}023.29$ ÷ N 2839.46 $\sigma = 53.29$

	W	W^1 (W×3.40)	N	$W^1 - N$	X	X^2
AZ	38	129	87	+ 42	19.61	384.55
AH	22	75	3	+ 72	10.39	107.95
AR	52	176	81	+ 95	33.39	1114.89
AW	35	119	105	+ 14	47.61	2266.71
BG	43	146	61	+ 85	23.39	547.09
BF	37	125	83	+ 42	19.61	384.55
BH	35	119	103	+ 16	45.61	2080.27
BHa	35	119	81	+ 38	23.61	557.43
DT	28	95	54	+ 41	20.61	424.77
EM	20	68	72	- 4	65.61	4304.67
GE	44	149	77	+ 72	10.39	107.95
GF	32	108	58	+ 50	11.61	134.79
GR	46	156	111	+ 45	16.61	275.89
HJ	51	173	97	+ 86	24.39	594.87
HE	9	31	75	- 44	105.61	11153.47
HH	62	210	119	+ 91	29.39	863.77
HL	20	68	39	+ 29	32.61	1063.41
KT	34	115	25	+ 90	28.39	805.99
KD	20	68	78	- 10	71.61	5127.99
LJ	37	126	88	+ 38	23.61	557.43
LW	31	105	47	+ 58	3.61	13.03
MW	46	156	79	+ 77	15.39	236.85
NA	53	180	15	+ 165	103.39	10689.49
NG	70	238	12	+ 226	164.39	27024.07
PG	37	126	83	+ 43	18.61	346.33
PA	54	184	73	+ 111	49.39	2439.37
RR	62	210	40	+ 170	108.39	11748.39
RM	31	105	81	+ 24	37.61	1414.51
SG	38	129	79	+ 50	11.61	134.79
VJ	46	156	87	+ 69	7.39	54.61
ZR	29	99	70	+ 29	32.61	1063.41

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{53.29}{\sqrt{30}}$$

$$= \frac{53.29}{5.48}$$

$$\sigma_M = 9.72$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{61.61}{9.72}$$

$$t = 6.38$$

*

significant at the 1% level

NUMBER AND REASONING

SUBJECT

$\Sigma = +427$ Dev $\Sigma = 42{,}487.21$
$M = 13.77$ From $\bar{N} = 1370.55$
Mean $\sigma = 37.02$

	N	R	Rx2.38 R^1	R - N	X	X^2
AZ	87	38	91	+ 4	9.77	95.45
AH	3	22	52	+ 49	35.23	1241.15
AR	81	58	138	+ 57	43.23	1868.83
AW	105	13	31	- 74	87.77	7703.57
BG	61	12	29	- 32	45.77	2094.89
BF	83	34	81	- 2	15.77	248.69
BH	103	30	71	- 32	45.77	2094.89
BHa	81	21	50	- 31	44.77	2004.35
DT	54	51	121	+ 67	53.23	2833.43
EM	72	51	121	+ 49	35.23	1241.15
GE	77	32	76	- 1	14.77	218.15
GF	58	41	98	+ 40	26.23	688.01
GR	111	34	81	- 30	43.77	1915.81
HJ	97	34	81	- 16	29.77	886.25
HE	75	35	83	+ 8	5.77	33.29
HH	119	42	100	- 19	32.77	1073.87
HL	39	25	60	+ 21	7.23	52.27
KT	25	37	88	+ 63	49.23	2423.59
KD	78	24	57	- 19	32.77	1073.87
LJ	88	62	148	+ 60	46.23	2137.21
LW	47	45	107	+ 60	46.23	2137.21
MW	79	28	67	- 12	25.77	664.09
NA	15	32	76	+ 61	47.23	2230.67
NG	12	31	74	+ 62	48.23	2326.13
PG	83	50	119	+ 36	22.23	494.17
PA	73	32	76	+ 3	16.77	281.23
RR	40	33	79	+ 39	25.23	636.55
RM	81	27	64	- 17	30.77	946.79
SG	79	44	105	+ 26	12.23	149.57
VJ	87	40	95	+ 8	21.77	473.93
ZR	70	29	69	- 1	14.77	218.15

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{37.02}{\sqrt{30}}$$

$$= \frac{37.02}{5.48}$$

$$\sigma_M = 6.75$$

$$= \frac{M_1 - M_2}{\sigma_M}$$

$$= \frac{13.77}{6.75}$$

$$t = 2.04$$

significant at the 5% level

NUMBER AND MEMORY

S
U
B
J
E
C
T

Σ = 251
$M = +8.10$

Σ = 27,503.91
$\div N$ = 887.22
σ = 29.79

	M	MX6.61 M^1	N	N-M	X	X^2
AZ	12	79	87	- 8	16.10	259.21
AH	3	20	3	- 17	25.10	630.01
AR	10	66	81	+ 15	6.90	47.61
AW	2	13	105	+ 92	83.90	7039.21
BG	5	33	61	+ 28	19.90	396.01
BF	7	46	83	+ 37	28.90	835.21
BH	10	66	103	+ 37	28.90	835.21
BHa	5	33	81	+ 48	39.90	1592.01
DT	11	73	54	- 19	27.10	734.41
EM	10	66	72	+ 6	2.10	4.41
GE	11	73	77	+ 4	4.10	16.81
GF	13	86	58	- 28	36.10	1303.21
GR	8	53	111	+ 58	49.90	2490.01
HJ	12	79	97	+ 18	9.90	98.01
HE	10	66	75	+ 9	.90	.81
HH	14	93	119	+ 26	17.90	320.41
HL	5	33	39	+ 6	2.10	4.41
KT	8	53	25	- 28	36.10	1303.21
KD	8	53	78	+ 25	16.90	285.61
LJ	13	86	88	+ 2	6.10	37.21
LW	6	40	47	+ 7	1.10	1.21
MW	14	93	79	- 14	5.90	34.81
NA	8	53	15	- 38	29.90	894.01
NG	9	59	12	- 47	55.10	3036.01
PG	17	112	83	- 29	37.10	1376.41
PA	6	40	73	+ 33	24.90	620.01
RR	8	53	40	- 13	21.10	445.21
RM	9	59	81	+ 22	13.90	193.21
SG	9	59	79	+ 20	11.90	141.61
VJ	8	53	87	+ 34	25.90	670.81
ZR	16	105	70	- 35	43.10	1857.60

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{29.79}{\sqrt{30}}$$

$$= \frac{29.79}{4.58}$$

$$\sigma_M = 5.44$$

$$t = \frac{M_1 - M_2}{\sigma_d M}$$

$$= \frac{8.10}{5.44}$$

$$t = 1.49$$

significant at the 50% level

SPATIAL AND VERBAL

SUBJECT

$\Sigma = 533$ $\quad \Sigma = 49211.67$

$M = 17.19$ $\quad N = 1587.47$

$\sigma = 39.84$

	S	V	Vxl.24 V^1	S-V	X	X^2
AZ	66	45	55	+ 11	8.19	67.07
AH	35	37	46	- 11	28.19	794.67
AR	68	79	98	- 30	47.19	2226.89
AW	83	21	26	+ 57	39.81	1584.84
BG	1	32	40	- 39	56.19	3157.32
BF	7	33	41	- 34	51.19	2620.42
BH	83	46	57	+ 26	8.81	77.62
BHa	71	9	11	+ 60	42.81	1832.70
DT	131	32	40	+ 91	73.81	5447.92
EM	21	23	29	- 8	25.19	634.54
GE	68	65	80	- 12	29.19	852.06
GF	86	51	63	+ 23	5.81	33.76
GR	65	40	50	+ 15	2.19	4.80
HJ	91	61	76	+ 15	2.19	4.80
HE	143	20	25	+ 118	100.81	10162.66
HH	84	67	83	+ 1	16.19	262.12
HL	47	20	25	+ 22	4.81	23.14
KT	49	48	60	- 11	28.19	794.67
KD	95	23	29	+ 66	48.81	2382.42
LJ	126	34	42	+ 84	66.81	4463.58
LW	69	47	59	+ 10	7.19	51.70
MW	61	56	69	- 8	25.19	634.54
NA	129	57	71	+ 58	40.81	1665.46
NG	76	73	91	- 15	32.19	1036.20
PG	52	51	63	- 11	28.19	794.67
PA	64	60	74	- 10	27.19	739.30
RR	4	52	64	- 60	77.19	5958.30
RM	68	32	40	+ 28	10.81	116.86
SG	107	66	82	+ 25	7.81	61.00
VJ	101	55	68	+ 33	15.81	249.96
ZR	72	27	33	+ 39	21.81	475.68

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{39.84}{\sqrt{31-1}}$$

$$= \frac{39.84}{5.48}$$

$$\sigma_M = 7.27$$

$$t = \frac{M_1 - M_2}{\sigma_{dM}}$$

$$= \frac{17.19}{7.27}$$

$$t = 2.36$$

significant at the 5% level

VERBAL AND WORD

SUBJECT

$\Sigma = 950$
$M = 30.65$

$\Sigma = 8424.02$
$N = 271.74$
$\sigma = 16.48$

	W	$W \times 1.93 = W^1$	V	$W^1 - V$	X	X^2
AZ	38	73	45	+ 28	2.65	7.02
AH	22	43	37	+ 6	24.65	607.62
AR	52	100	79	+ 21	9.65	93.12
AW	35	68	21	+ 47	16.35	267.32
BG	43	83	32	+ 51	20.35	414.12
BF	37	71	33	+ 38	7.35	54.02
BH	35	68	46	+ 22	8.65	74.82
BHa	35	68	9	+ 59	28.35	803.72
DT	28	54	32	+ 22	8.65	74.82
EM	20	39	23	+ 16	14.65	214.62
GE	44	85	65	+ 20	10.65	113.42
GF	32	62	51	+ 11	19.65	386.12
GR	46	89	40	+ 49	18.35	336.72
HJ	51	98	61	+ 37	6.35	40.32
HE	9	17	20	- 3	33.65	1132.32
HH	62	120	67	+ 53	22.35	499.52
HL	20	39	20	+ 19	11.65	135.72
KT	34	66	48	+ 18	12.65	160.02
KD	20	39	23	+ 16	14.65	214.62
LJ	37	71	34	+ 37	6.35	40.32
LW	31	60	47	+ 13	17.65	311.52
MW	46	89	56	+ 33	2.35	5.52
NA	53	102	57	+ 45	14.35	205.92
NG	70	135	73	+ 62	31.35	982.82
PG	37	71	51	+ 20	10.65	113.42
PA	54	104	60	+ 44	13.35	178.22
RR	62	120	52	+ 68	37.35	1395.02
RM	31	60	32	+ 28	2.65	7.02
SG	38	73	66	+ 7	23.65	559.32
VJ	46	89	55	+ 34	3.35	11.22
ZR	29	56	27	+ 29	1.65	2.72

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{16.48}{\sqrt{31-1}}$$

$$= \frac{16.48}{5.48}$$

$$\sigma_M = 3.01$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{30.65}{3.01}$$

$$t = 10.18$$

significant at the 1% level

VERBAL AND REASONING

	Reasoning R	Rxl.35 R^1	Verbal V	$V-R^1$	X	X^2
AZ	38	51	45	- 6	2.52	6.35
AH	22	30	37	+ 7	10.48	109.83
AR	58	78	79	+ 1	4.48	20.07
AW	13	18	21	+ 3	6.48	41.99
BG	12	16	32	+16	19.48	379.47
BF	34	46	33	-13	9.52	90.63
BH	30	41	46	+ 5	8.48	71.91
BHa	21	28	9	-19	15.52	240.87
DT	51	69	32	-37	33.52	1123.59
EM	51	69	23	-46	42.52	1807.95
GE	32	43	65	+22	25.48	649.23
GF	41	55	51	- 4	.52	.27
GR	34	46	40	- 6	2.52	6.35
HJ	34	46	61	+15	18.48	341.51
HE	35	47	20	-27	23.52	553.19
HH	42	57	67	+10	13.48	181.71
HL	25	34	20	-14	10.52	110.67
KT	27	50	48	- 2	1.48	2.19
KD	24	32	23	- 9	5.52	30.47
LJ	62	84	34	-50	46.52	2164.11
LW	45	61	47	-14	10.52	110.67
MW	28	38	56	+18	21.48	461.39
NA	32	43	57	+12	15.48	239.63
NG	31	42	73	+31	34.48	1188.87
PG	50	68	51	-17	13.52	182.79
PA	32	43	60	+17	20.48	419.43
RR	33	45	52	+ 7	10.48	109.83
RM	27	36	32	- 4	.52	.27
SG	44	59	66	+ 7	10.48	109.83
VJ	40	54	55	+ 1	4.48	20.07
ZR	29	39	27	-12	.52	.27
						$\Sigma = 10775.41$
				$\Sigma = -108$		$\div N = 347.59$
				$M = -3.48$		$\sigma = 18.64$

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{18.64}{\sqrt{31-1}}$$

$$= \frac{18.64}{5.48}$$

$$\sigma_M = 3.40$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{3.48}{3.40}$$

$$t = 1.02$$

significant at the 50% level

VERBAL AND MEMORY

SUBJECT

$\Sigma = +242$
$M = 7.82$

$\Sigma = 10778.25$
$\div N = 347.69$
$\sigma = 18.65$

Mx3.75

	M	M	V	V-M	X	X
AZ	12	45	45	+ 0	7.82	61.15
AH	3	11	37	+26	18.18	330.51
AR	10	38	79	+41	33.18	1100.91
AW	2	8	21	+13	5.18	26.83
BG	5	19	32	+13	5.18	26.83
BF	7	26	33	+ 7	.82	.67
BH	10	38	46	+ 8	.18	.03
BHa	5	19	9	-10	17.82	317.55
DT	11	41	32	- 9	16.82	282.91
EM	10	38	23	-15	22.82	520.75
GE	11	41	65	-24	31.82	1012.51
GF	13	49	51	+ 2	5.82	33.87
GR	8	30	40	+10	2.18	4.75
HJ	12	45	61	+16	8.18	66.91
HE	10	38	20	-18	25.82	666.15
HH	14	53	67	+14	6.18	38.19
HL	5	19	20	+ 1	6.82	46.51
KT	8	30	48	+18	10.18	103.63
KD	8	30	23	- 7	14.82	219.63
LJ	13	49	34	- 5	12.82	164.35
LW	6	23	47	+24	16.18	261.79
MW	14	53	56	+ 3	4.82	23.23
NA	8	30	57	+27	19.18	367.87
NG	9	34	73	+39	31.18	972.19
PG	17	64	51	-13	20.82	433.47
PA	6	23	60	+37	29.18	851.47
RR	8	30	52	+22	14.18	201.07
RM	9	34	32	- 2	9.82	96.43
SG	9	34	66	+32	24.18	584.67
VJ	8	30	55	+25	17.18	295.15
ZR	16	60	27	-33	40.82	1666.27

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{18.65}{\sqrt{31-1}}$$

$$= \frac{18.65}{5.48}$$

$$\sigma_M = 3.40$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{7.82}{3.40}$$

$$t = 2.30$$

significant at the 5% level

SPACE WORD Wx2.40

	S	W	W^1	W^1-S	X	X^2
AZ	66	38	91	+ 25	.16	.03
AH	35	22	53	+ 18	7.16	51.27
AR	68	52	125	+ 57	25.84	667.71
AW	83	35	84	+ 1	24.16	583.71
BG	1	43	103	+102	76.84	5904.39
BF	7	37	89	+ 82	56.84	3230.79
BH	83	35	84	+ 1	24.16	583.71
BHa	71	35	84	+ 13	12.16	147.87
DT	131	28	67	+ 64	38.84	1508.55
EM	21	20	48	+ 27	1.84	3.39
GE	68	44	106	+ 38	12.84	164.87
GF	86	32	77	- 9	34.16	1166.91
GR	65	46	110	+ 45	19.84	393.63
HJ	91	51	122	+ 31	5.84	34.11
HE	143	9	22	-121	146.16	21362.75
HH	84	62	149	+ 65	39.84	1587.23
HL	47	20	48	+ 1	24.16	583.71
KT	49	34	82	+ 33	7.84	61.47
KD	95	20	48	- 47	72.16	5207.07
LJ	126	37	89	- 37	62.16	3863.87
LW	69	31	74	+ 5	20.16	406.43
MW	61	46	110	+ 49	23.84	568.34
NA	129	53	127	- 2	27.16	737.67
NG	76	70	168	+ 92	66.84	4467.59
PG	52	37	89	+ 37	11.84	140.19
PA	64	54	130	+ 66	40.84	1667.91
RR	4	62	149	+145	119.84	14361.62
RM	68	31	74	+ 6	19.16	367.11
SG	107	38	91	- 16	41.16	1694.15
VJ	101	46	110	+ 9	16.16	261.15
ZR	72	29	70	- 2	27.16	737.67

Σ= 780
M= 25.16

Σ= 72516.87
÷ N= 2339.25
σ = 48.37

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{48.37}{\sqrt{31-1}}$$

$$= \frac{48.37}{5.48}$$

$$\sigma_M = 8.83$$

$$t = \frac{M_1 - M_2}{\sigma_d M}$$

$$= \frac{25.16}{8.83}$$

$$t = 2.85$$

significant at the 1% level

SPATIAL AND REASONING

SPACE REASONING Rxl.68

	S	R	R^1	$S-R^1$	X	X^2
AZ	66	38	64	- 2	17.90	320.41
AH	35	22	37	- 2	17.90	320.41
AR	68	58	97	- 29	44.90	2016.01
AW	83	13	22	+ 61	45.10	2034.01
BG	1	12	20	- 19	34.90	1218.01
BF	77	34	57	- 50	65.90	4342.81
BH	83	30	50	+ 33	17.10	292.41
BHa	71	21	35	+ 36	20.10	404.01
DT	131	51	86	+ 45	19.10	364.81
EM	21	51	86	- 65	80.90	6544.81
GE	68	32	54	+ 14	1.90	3.61
GF	86	41	69	+ 17	1.10	1.21
GR	65	34	57	+ 8	7.90	62.41
HJ	91	34	57	+ 34	18.10	327.61
HE	143	35	59	+ 84	68.10	4637.61
HH	84	42	71	+ 13	2.90	8.41
HL	47	25	42	+ 5	10.90	118.81
KT	49	37	62	- 13	28.90	835.21
KD	95	24	40	+ 55	39.10	1528.81
LJ	126	62	104	+ 122	106.10	11257.21
LW	69	45	76	- 7	22.90	524.41
MW	61	28	47	+ 14	1.90	3.61
NA	129	32	54	+ 75	59.10	3492.81
NG	76	31	52	+ 24	8.10	65.61
PG	52	50	84	- 32	47.90	2294.41
PA	64	32	54	+ 10	5.90	34.81
RR	4	33	55	- 51	66.90	4475.61
RM	68	27	45	+ 23	7.10	50.41
SG	107	44	74	+ 33	17.10	50.41
VJ	101	40	67	+ 34	18.10	327.61
ZR	72	29	49	+ 23	7.10	50.41

Σ = 493
M = 15.90

Σ = 48008.71
÷N = 1548.67
σ = 39.35

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{39.35}{\sqrt{31-1}}$$

$$= \frac{39.35}{5.48}$$

$$\sigma_M = 7.18$$

$$t = \frac{M_1 - M_2}{\sigma_{dM}}$$

$$= \frac{15.90}{7.18}$$

$$t = 2.21$$

significant at the 5% level

SPATIAL AND MEMORY

	SPACE S	MEMORY M	Mx4.67 M^1	$S-M^1$	X	X^2
AZ	66	12	56	+10	18.65	347.82
AH	35	3	14	+21	7.65	58.52
AR	68	10	47	+21	7.65	58.52
AW	83	2	9	+74	45.35	2055.62
BG	1	5	23	-22	50.65	2565.42
BF	7	7	33	-26	54.65	2986.62
BH	83	10	47	+36	7.35	54.02
BHa	71	5	23	+48	19.35	374.42
DT	131	11	51	+80	51.35	2636.82
EM	21	10	47	-26	54.65	2986.65
GE	68	11	51	+17	11.65	135.72
GF	86	13	60	+26	2.65	7.02
GR	65	8	37	+28	.65	.42
HJ	91	12	56	+35	6.35	40.32
HE	143	10	47	+96	67.35	4536.02
HH	84	14	65	+19	9.65	93.12
HL	47	5	23	+24	4.65	21.62
KT	49	8	37	+12	16.65	277.22
KD	95	8	37	+58	29.35	861.42
LJ	126	13	60	+66	37.35	1395.02
EW	69	6	28	+41	12.35	152.52
MW	61	14	65	- 4	32.65	1066.02
NA	129	8	37	+92	63.35	4013.22
NG	76	9	42	+34	5.35	28.62
PG	52	17	79	-27	55.65	3096.92
PA	64	6	28	+36	7.35	54.02
RR	4	8	37	-33	61.65	3800.72
RM	68	9	42	+26	2.65	7.02
SG	107	9	42	+65	36.35	1321.32
VJ	101	8	37	+64	35.35	1249.62
ZR	72	16	75	- 3	31.65	1001.72

Σ = 888
M = 28.65

Σ = 37285.05
$\div N$ = 1202.74
σ = 34.68

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{34.68}{\sqrt{31-1}}$$

$$= \frac{34.68}{5.48}$$

$$\sigma_M = 6.33$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{28.65}{6.33}$$

$$t = 4.52$$

Significant at the 1% level

WORD & REASONING

SUBJECT

$\Sigma = +643$ $\Sigma = 14593.93$

$M = -20.74$ $\div N = 470.77$

$\sigma = 21.70$

WX1.43

	W	W^1	R	W^1-R	X	X^2
AZ	38	54	38	+16	4.74	22.47
AH	22	31	22	+ 9	11.74	137.82
AR	52	74	58	+16	4.74	22.47
AW	35	50	13	+37	16.26	264.39
BG	43	61	12	+49	28.26	798.63
BF	37	53	34	+19	1.74	3.03
BH	35	50	30	+20	.74	.55
BHa	35	50	21	+29	8.26	68.23
DT	28	40	51	-11	31.74	1007.43
EM	20	29	51	-22	44.74	2001.67
GE	44	63	32	+31	10.26	105.27
GF	32	46	41	+ 5	15.74	247.75
GR	46	66	34	+32	11.26	126.79
HJ	51	73	34	+39	18.26	333.43
HE	9	13	35	-22	44.74	2001.67
HH	62	89	42	+47	26.26	689.59
HL	20	29	25	+ 4	16.74	280.23
KT	34	49	37	+12	8.74	76.39
KD	20	29	24	+ 5	15.74	247.75
LJ	37	53	62	+ 9	11.74	137.83
LW	31	44	45	- 1	21.74	472.63
MW	46	66	28	+38	17.26	297.91
NA	53	76	32	+44	23.26	541.03
NG	70	100	31	+69	48.26	2329.03
PG	37	53	50	+ 3	17.74	314.71
PA	54	77	32	+45	24.26	588.55
RR	62	89	33	+56	35.26	1243.27
RM	31	44	27	+17	3.74	13.99
SG	38	54	44	+10	10.74	115.35
VJ	46	66	40	+26	5.26	27.67
ZR	29	41	29	+12	8.74	76.39

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{21.70}{\sqrt{31-1}}$$

$$= \frac{21.70}{5.48}$$

$$\sigma_M = 3.96$$

$$t = \frac{M_1 - M_2}{\sigma_M}$$

$$= \frac{20.74}{3.96}$$

$$t = 5.24$$

Significant at the 1% level

WORD AND MEMORY

SUBJECT

Σ=+642 M=20.71 Σ=6420.26 ÷N=206.47 σ=14.37

Mx1.94

	W	M	M^1	W-M^1	X	X^2
AZ	38	12	23	+ 15	5.71	32.60
AH	22	3	6	+ 16	4.71	22.18
AR	52	10	19	+ 33	12.29	151.04
AW	35	2	4	+ 33	12.29	151.04
BG	43	5	10	+ 33	12.29	151.04
BF	37	7	14	+ 23	2.29	5.24
BH	35	10	19	+ 16	4.71	22.18
BHa	35	5	10	+ 25	4.29	18.40
DT	28	11	21	+ 7	13.71	187.96
EM	20	10	19	+ 1	19.71	388.48
GE	44	11	21	+ 23	2.29	5.24
GF	32	13	25	+ 7	13.71	187.96
GR	46	8	16	+ 30	9.29	86.30
HJ	51	12	23	+ 28	7.29	53.14
HE	9	10	19	- 10	30.71	943.10
HH	62	14	27	+ 35	14.29	204.20
HL	20	5	10	+ 10	10.71	114.70
KT	34	8	16	+ 18	2.71	7.34
KD	20	8	16	+ 4	16.71	279.22
LJ	37	13	25	+ 12	8.71	75.86
LW	31	6	12	+ 19	1.71	2.92
MW	46	14	27	+ 19	1.71	2.92
NA	53	8	16	+ 37	16.29	265.36
NG	70	9	17	+ 53	32.29	1042.64
PG	37	17	33	+ 4	16.71	279.22
PA	54	6	12	+ 42	21.29	453.26
RR	62	8	16	+ 46	25.29	639.58
RM	31	9	17	+ 14	6.71	45.02
SG	38	9	17	+ 21	.29	.08
VJ	46	8	16	+ 30	9.29	86.30
ZR	29	16	31	- 2	22.71	515.74

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{14.37}{\sqrt{31-1}}$$

$$= \frac{14.37}{5.48}$$

$$\sigma_M = 2.62$$

$$t = \frac{M_1 - M_2}{\sigma_{dM}}$$

$$= \frac{20.71}{2.62}$$

$$t = 7.90$$

Significant at the 1% level

REASONING AND MEMORY

SUBJECT

$\Sigma = 292$ $\quad \Sigma = 3281.49$

$M = 9.42$ $\quad \div N = 105.85$

$\sigma = 10.29$

Mx2.77

	M	M^1	R	$R-M^1$	X	X^2
AZ	12	33	38	+ 5	4.42	19.54
AH	3	8	22	+14	4.58	20.98
AR	10	28	58	+30	20.58	423.54
AW	2	6	13	+ 7	2.42	5.86
BG	5	14	12	- 2	11.42	130.42
BF	7	19	34	+15	5.58	31.14
BH	10	28	30	+ 2	7.42	55.06
BHa	5	14	21	+ 7	2.42	5.86
DT	11	30	51	+21	11.58	134.10
EM	10	28	51	+23	13.58	184.42
GE	11	30	32	+ 2	7.42	55.06
GF	13	36	41	+ 5	4.42	19.54
GR	8	22	34	+12	2.58	6.66
HJ	12	33	34	+ 1	8.42	70.90
HE	10	28	35	+ 7	2.42	5.86
HH	14	39	42	+ 3	6.42	41.22
HL	5	14	25	+11	1.58	2.50
KT	8	22	37	+15	5.58	31.14
KD	8	22	24	+ 2	7.42	55.06
LJ	13	36	62	+26	16.58	274.90
LW	6	17	45	+28	18.58	345.22
MW	14	39	28	-11	21.42	458.82
NA	8	22	32	+10	.58	.34
NG	9	25	31	+ 6	3.42	11.70
PG	17	47	50	+ 3	6.42	41.22
PA	6	17	32	+15	5.58	31.14
RR	8	22	33	+11	1.58	2.50
RM	9	25	27	+ 2	7.42	55.06
SG	9	25	44	+19	9.58	91.78
VJ	8	22	40	+18	8.58	73.62
ZR	16	44	29	-15	24.42	596.33

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{10.29}{\sqrt{31-1}}$$

$$= \frac{10.29}{5.48}$$

$$\sigma_M = 1.88$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{9.42}{1.88}$$

$$t = 5.01$$

Significant at the 1% level

APPENDIX C

CALCULATIONS RELATED TO GROUPS ONE AND TWO

GROUP 1

NUMBER & VERBAL

S VERBAL Vx1.76 NUMBER Σ = 248
U M = 41.33
B
J V V^1 N V^1-N X X^2

BH	46	81	103	- 22	63.33	4010.69
KT	48	84	25	+ 59	17.67	312.23
NG	73	128	12	+116	74.67	5575.61
PA	60	106	73	+ 33	8.33	69.39
RR	52	92	40	+ 52	10.67	113.85
VJ	55	97	87	+ 10	31.33	981.57

Σ= 11063.34
÷N= 1843.89
σ 42.94

$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$

$= \frac{42.94}{\sqrt{N-1}}$

$= \frac{42.94}{2.24}$

σ_M= 19.15

$T = \frac{M_1 - M_2}{\sigma_d M}$

$= \frac{41.33}{19.15}$

t= 2.16

Significant at the 10% level

GROUP 2

NUMBER & VERBAL

S
U
B
J N V Vx1.76 V^1 $N-V^1$ X X^2

PG	83	51	90	- 7	29.83	889.82
GR	111	40	70	+ 41	18.17	330.15
KD	78	23	40	+ 38	15.17	230.13
BHa	81	9	16	+ 45	22.17	491.51
DT	54	32	56	+ 2	24.83	616.53
ZR	70	27	48	+ 22	.83	.69

Σ = 137
M = 22.83

Σ= 2558.83
÷N= 426.47
σ = 20.65

$\sigma_M = \frac{\sigma}{N-1}$

$= \frac{20.65}{2.24}$

σ_M = 9.22

$t = \frac{M_1 - M_2}{\sigma_M}$

$= \frac{22.83}{9.22}$

t = 2.48

Significant at the 10% level

NUMBER & SPATIAL

GROUP 1

SPACE Sx1.42 NUMBER

	S	S^1	N	S^1-N	X	X^2
BH	83	118	103	+15	19.33	373.65
KT	49	70	25	+45	10.67	113.85
NG	76	108	12	+106	71.67	5136.59
PA	64	91	73	+18	16.33	266.67
RR	4	6	40	+34	68.33	4668.99
VJ	101	143	87	56	21.67	469.59

Σ= 206 Σ=11029.34
M= 34.33 ÷N=1838.22
σ=42.87

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{42.87}{\sqrt{6-1}} = \frac{42.87}{2.24}$$

$$\sigma_M = 19.14$$

$$t = \frac{M_1 - M_2}{\sigma_{dM}} = \frac{34.33}{19.14}$$

$$t = 2.16$$

Significant at the 10% level

GROUP 2

SPACE Sx1.42 NUMBER

	S	S^1	N	S^1-N	X	X^2
PG	52	74	83	- 9	44.50	1980.25
GR	65	92	111	-19	54.50	2970.25
KD	95	135	78	+57	21.50	462.25
BHa	71	101	81	+20	15.50	240.25
DT	131	186	54	+132	96.50	9312.25
ZR	72	102	70	+32	3.50	12.25

Σ= 213 Σ=14977.50
M= 35.50 ÷N=2496.25
σ= 49.96

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{49.96}{\sqrt{6-1}} = \frac{49.96}{2.24}$$

$$\sigma_M = 20.52$$

$$CR = \frac{M_1 - M_2}{M} = \frac{35.50}{20.52}$$

$$CR = 1.73$$

Significant at the 50% level

GROUP 1

NUMBER AND WORD

WORD Wx3.40 NUMBER

	W	W^1	N	W^1-N	X	X^2
BH	35	119	103	16	86.33	7452.87
KT	34	115	25	+ 90	12.33	152.03
NG	70	238	12	+ 226	123.67	15294.27
PA	37	126	83	+ 43	59.33	3520.05
RR	62	210	40	+ 170	67.67	4579.23
VJ	46	156	87	+ 69	33.33	1110.89
				+		"

Σ=614 M=102.33 Σ=32109.34 ÷N=5351.66 σ=73.16

Significant at the 5% level

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{73.16}{\sqrt{6-1}} = \frac{73.16}{2.24} = 32.66$$

σ_M = 32.66

$$t = \frac{M_1 - M_2}{\sigma_{dM}}$$

$$t = \frac{102.33}{32.66}$$

$$t = 3.13$$

GROUP 2

WORD Wx3.40 NUMBER

	W	W^1	N	W^1-N	X	X^2
PG	37	126	83	43	13.00	169.00
GR	46	156	111	+45	15.00	225.00
KD	20	68	78	+10	40.00	1600.00
BHa	35	119	81	-38	8.00	64.00
DT	28	95	54	+41	11.00	121.00
ZR	29	99	70	+29	1.00	1.00
				+		

Σ=186 M=30.00 Σ=2180 ÷M=363.33 σ=19.06

Significant at the 5% level

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{19.06}{\sqrt{6-1}} = \frac{19.06}{2.24}$$

σ_M = 8.51

$$t = \frac{M_1 - M_2}{\sigma_{dM}} = \frac{30.00}{8.51}$$

$$t = 3.53$$

NUMBER AND REASONING

GROUP 1

	REASONING R	Rx2.38 R^1	N	R^1-N	X	X^2
BH	30	71	103	-32	55.83	3116.99
KT	37	88	25	+63	39.17	1534.29
NG	31	74	12	+62	38.17	1456.57
PA	32	76	73	+ 3	20.83	433.89
RR	33	79	40	+39	15.17	230.13
VJ	40	95	87	+ 8	15.83	250.59
				Σ=143		Σ=7022.46
				M=23.83		÷N=1170.41
						σ=34.21

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{34.21}{\sqrt{6-1}} = \frac{34.21}{2.24}$$

$$\sigma_M = 15.27$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{23.83}{15.27}$$

$$t = 1.56$$

Significant at the 50% level

GROUP 2

	REASONING R	Rx2.38 R^1	N	R^1-N	X	X^2
PG	50	119	83	+36	32.34	1045.88
GR	34	81	111	-30	33.66	1133.00
KD	24	57	78	-19	22.66	513.48
BHa	21	50	81	-31	34.66	1201.32
DT	51	121	54	-67	63.34	4011.96
ZR	29	69	70	+ 1	4.66	21.72
				Σ=+22		Σ=7927.36
				M=3.66		N=1321.23
						=36.35

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{36.35}{\sqrt{6-1}} = \frac{36.35}{2.24}$$

$$\sigma_M = 16.23$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{3.66}{16.23}$$

$$t = .23$$

Not significant at the 50% level

NUMBER AND MEMORY

GROUP 1

	MEMORY Mx6.61 M	M^1	NUMBER N	M^1-N	X	X^2
BH	10	66	103	-37	34.34	1179.24
KT	8	53	25	+28	30.66	940.03
NG	9	59	12	+47	49.66	2466.12
PA	6	40	73	-33	30.34	920.52
RR	8	53	40	+13	15.66	245.24
VJ	8	53	87	-34	31.34	982.20
				Σ=-16		Σ=6763.35
				M=- 2.66		÷N=1127.23
						σ =33.58

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{33.58}{\sqrt{6-1}} = \frac{33.58}{2.24}$$

$$\sigma_M = 14.99$$

$$t = \frac{M_1 - M_2}{\sigma_{dM}} = \frac{2.66}{14.99}$$

$$t = .18$$

Not significant at the 50% level

GROUP 2

	MEMORY Mx6.61 M	M^1	NUMBER N	M^1-N	X	X^2
PG	17	112	83	+29	37.00	1369.00
GR	8	53	111	-58	50.00	2500.00
KD	8	53	78	-25	17.00	289.00
BHa	5	33	81	-48	40.00	1600.00
DT	11	73	54	+19	27.00	729.00
ZR	16	105	70	+35	43.00	1849.00
				Σ=-48		Σ=8336.00
				M=-8.00		÷N=1389.33
						σ=37.27

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{37.27}{\sqrt{6-1}} = \frac{37.27}{2.24}$$

$$\sigma_M = 16.64$$

$$t = \frac{M_1 - M_2}{\sigma_{dM}} = \frac{8.00}{16.64}$$

$$t = .48$$

Not significant at the 50% level

SPATIAL AND VERBAL

GROUP 1

	SPACE S	VERBAL V	Vx1.24 V^1	$S-V^1$	X	X^2
BH	83	46	57	+26	32.17	1034.91
KT	49	48	60	-11	4.83	23.33
NG	76	73	91	-15	8.83	77.97
PA	64	60	74	-10	3.83	14.67
RR	4	52 2	64	-60	53.83	2897.67
VJ	101	55	68	+33	39.17	1534.29
				Σ=-37		Σ=5582.84
				M=-6.17		÷N=930.47
						σ=30.50

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{30.50}{\sqrt{6-1}}$$

$$= \frac{30.50}{2.24}$$

$$\sigma_M = 13.61$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{6.17}{13.61}$$

$$t = .45$$

Not significant at the 50% level

GROUP 2

	SPACE S	VERBAL V	Vx1.24 V^1	$S-V^1$	X	X^2
PG	52	51	63	-11	54.33	2951.75
GR	65	40	50	+15	28.33	802.59
KD	95	23	29	+66	22.67	513.93
BHa	71	9	11	+60	16.67	277.89
DT	131	32	40	+91	47.67	2272.43
ZR	72	27	33	+39	4.33	18.75
				Σ=+260		Σ=6837.34
				M=+43.33		÷N=1139.56
						σ=33.76

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{33.76}{\sqrt{6-1}}$$

$$= \frac{33.76}{2.24}$$

$$\sigma_M = 15.45$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{43.33}{15.45}$$

$$t = 2.84$$

Significant at the 5% level

VERBAL AND WORD

GROUP 1

	WORD W	Wx1.93 W^1	VERBAL V	W^1-V	X	X^2
BH	35	68	46	+ 22	19.33	373.65
KT	34	66	48	+ 18	23.33	544.29
NG	70	135	73	+ 62	20.67	427.25
PA	54	104	60	+ 44	2.67	7.13
RR	62	120	52	+ 68	26.67	711.29
VJ	46	89	55	+ 34	7.33	53.73

Σ=248 M=41.33 Σ=2117.34 ÷N=352.89 σ=18.79

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{18.79}{\sqrt{6-1}} = \frac{18.79}{2.24}$$

$$\sigma_M = 8.39$$

$$t = \frac{M_1 - M_2}{\sigma_d M} \qquad \frac{41.33}{8.39}$$

$$t = 4.93$$

Significant at the 1% level

GROUP 2

	WORD W	Wx1.93 W^1	VERBAL V	W^1-V	X	X^2
PG	37	71	51	+20	12.50	156.25
GR	46	89	40	+49	16.50	272.25
KD	20	39	23	+16	16.50	272.25
BHa	35	68	9	+59	26.50	702.25
DT	28	54	32	+22	10.50	110.25
ZR	29	56	27	+29	3.50	12.25

Σ=195 M=32.50 Σ=1525.50 ÷N=254.25 σ=15.95

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{15.95}{\sqrt{6-1}} = \frac{15.95}{2.24}$$

$$\sigma_M = 7.12$$

$$t = \frac{M_1 - M_2}{\sigma_d M} = \frac{32.50}{7.12}$$

$$t = 4.56$$

Significant at the 1% level

VERBAL AND REASONING

GROUP 1

	REASONING R	Rx1.35 R^1	VERBAL V	$V-R^1$	X	X^2
BH	30	41	46	+5	4.83	23.33
KT	37	50	48	-2	11.83	139.95
NG	31	42	73	+31	21.17	448.17
PA	32	43	69	+17	7.17	51.41
RR	33	45	52	+ 7	2.83	5.18
VJ	40	54	55	+ 1	7.83	61.31
				Σ=+59		Σ=729.35
				M=9.83		÷N=123.56
						σ=11.03

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{11.03}{\sqrt{6-1}}$$

$$= \frac{11.03}{2.24}$$

$$\sigma_M = 4.92$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{9.83}{4.92}$$

$$t = 2.00$$

Significant at the 10% level

GROUP 2

	REASONING R	Rx1.35 R^1	VERBAL V	$V-R^1$	X	X^2
PG	50	68	51	-17	2	4.00
GR	34	46	40	- 6	9	81.00
KD	24	32	23	- 9	6	36.00
BHa	21	28	9	- 9	6	36.00
DT	51	69	32	-37	12	144.00
ZR	29	39	27	-12	3	9.00
				Σ=-90		Σ=310
				M=-15		÷N=51.66
						σ = 7.19

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{7.19}{\sqrt{6-1}}$$

$$\sigma_M = \frac{7.19}{2.24}$$

$$\sigma_M = 3.21$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$\frac{15.00}{3.21}$$

$$t = 4.67$$

Significant at the 1% level

VERBAL AND MEMORY

GROUP 1

	MEMORY M	Mx3.75 M^1	VERBAL V	$V-M^1$	X	X^2
BH	10	38	46	+ 8	16.83	283.25
KT	8	30	48	+18	6.83	46.65
NG	9	34	73	+39	14.17	200.79
PA	6	23	60	+37	12.17	148.11
RR	8	30	52	+22	2.83	8.01
VJ	8	30	55	+25	.17	.03

Σ=+149 Σ=686.84
M=24.83 ÷N=114.47
σ = 10.70

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{10.70}{\sqrt{6-1}} = \frac{10.70}{2.24}$$

$$\sigma_M = 4.78$$

$$t = \frac{M_1 - M_2}{\sigma_{dM}} = \frac{24.83}{4.78}$$

$$t = 5.19$$

Significant at the 1% level

GROUP 2

	MEMORY M	Mx3.75 M^1	VERBAL V	$V-M^1$	X	X^2
PG	17	64	51	-13	6.84	46.79
GR	8	30	40	+10	16.16	261.15
KD	8	30	48	+18	24.16	587.71
BHa	5	19	9	-10	3.84	14.75
DT	11	41	32	- 9	2.84	8.07
ZR	16	60	27	-33	26.84	720.39

Σ=-37 Σ=1638.86
M=-6.16 ÷N=273.14
σ = 16.53

$$\sigma_M = \frac{\sigma}{N-1} = \frac{16.53}{6-1} = \frac{16.53}{2.24}$$

$$\sigma_M = 7.38$$

$$t = \frac{M_1 - M_2}{\sigma_{dM}} = \frac{6.16}{7.38}$$

$$t = .83$$

Significant at the 50% level

SPATIAL AND WORD

GROUP 1

	WORD W	Wx2.40 W^1	SPACE S	W^1-S	X	X^2
BH	35	84	83	+ 1	55.66	3098.04
KT	34	82	49	+33	23.66	559.80
NG	70	168	76	+92	35.34	1248.92
PA	54	130	64	+66	9.34	87.24
RR	62	149	4	+145	88.34	7803.96
VJ	46	110	101	+ 9	47.66	2271.47

Σ=340 M=56.66 Σ=15069.43 ÷N=2511.57 σ = 50.12

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{50.12}{\sqrt{6-1}} = \frac{50.12}{2.24}$$

$$\sigma_M = 22.37$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{56.66}{22.37}$$

$$t = 2.53$$

Significant at the 10% level

GROUP 2

	WORD W	Wx2.40 W^1	SPACE S	W^1-S	X	X^2
PG	37	89	52	+ 37	40.00	1600.00
GR	46	110	65	+ 45	48.00	2304.00
KD	20	48	95	- 47	44.00	1936.00
BHa	35	84	71	+ 13	16.00	256.00
DT	28	67	131	- 64	61.00	3721.00
ZR	29	70	72	- 2	1.00	1.00

Σ=18 M=3.00 Σ=9818.00 ÷N=1636.33 σ=40.45

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{40.45}{\sqrt{6-1}} = \frac{40.45}{2.24}$$

$$M = 18.06$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{3.00}{18.06}$$

$$t = .16$$

Not significant at the 50% level

SPATIAL AND REASONING

GROUP 1

	SPACE S	REASONING R	Rx1.68 R^1	S - R^1	X	X^2
BH	83	30	50	+33	26.84	720.39
KT	49	37	62	-13	19.16	367.11
NG	76	31	52	+24	17.84	318.27
PA	64	32	54	+10	3.84	14.75
RR	4	33	55	-51	57.16	3267.27
VJ	101	40	67	+34	27.84	775.07

Σ=+37 Σ=5462.86
M=+6.16 ÷N=910.48
σ=30.17

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{30.17}{\sqrt{6-1}} = \frac{30.17}{2.24} = 13.47$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$t = \frac{6.16}{13.47}$$

$$t = .46$$

Not significant at the 50% level

GROUP 2

	SPACE S	REASONING R	Rx1.68 R^1	S-R^1	X	X^2
PG	52	50	84	-32	54.50	2970.25
GR	65	34	57	+8	14.50	210.25
KD	95	24	40	+55	32.50	1056.25
BHa	71	21	35	+36	13.50	182.25
DT	131	51	86	+45	22.50	506.25
ZR	72	29	49	+23	.50	.25

Σ=135 Σ=4925.50
M=22.50 ÷N=820.92
σ=28.65

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{28.65}{2.24} = 12.79$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{22.50}{12.79}$$

$$t = 1.76$$

Significant at the 50% level

SPATIAL AND MEMORY

GROUP 1

	SPACE S	MEM-ORY M	Mx4.67 M^1	$S-M^1$	X	X^2
BH	83	10	47	+36	11.17	124.77
KT	49	8	37	+12	12.83	164.61
NG	76	9	42	+34	9.17	84.09
PA	64	6	28	+36	11.17	124.77
RR	4	8	37	-33	57.83	3344.31
VJ	101	8	37	+64	39.17	1534.29

Σ=149 M=24.83

Σ=5376.84 N=899.14 = 29.98

Significant at the 50% level

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{29.98}{\sqrt{6-1}} = \frac{29.98}{2.24} = 13.38$$

$$\sigma_M = 13.38$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{24.83}{13.38}$$

$$t = 1.86$$

GROUP 2

	SPACE S	MEM-ORY M	Mx4.67 M^1	$S-M^1$	X	X^2
PG	52	17	79	-27	57.66	3324.68
GR	65	8	37	+28	2.66	7.08
KD	95	8	37	+58	27.34	747.48
BHa	71	5	23	+48	17.34	300.68
DT	131	11	51	+80	49.34	2434.45
ZR	72	16	75	- 3	33.66	1133.00

Σ= 184 M= 30.66

Σ=7947.37 ÷N=1324.56 σ= 36.39

Significant at the 50% level

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{36.39}{\sqrt{6-1}} = \frac{36.39}{2.24} = 16.25$$

$$\sigma_M = 16.25$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{30.66}{16.25}$$

$$t = 1.89$$

WORD AND REASONING

GR1)	Word W	Wxl.43 W^1	Reasoning R	W^1-R	X	X^2
BH	35	50	30	+ 20	18.00	324.00
KT	34	49	37	+ 12	26.00	676.00
NG	70	100	31	+ 69	31.00	961.00
PA	54	77	32	+ 45	7.00	49.00
RR	62	89	33	+ 56	18.00	324.00
VJ	46	66	40	+ 26	12.00	144.00

$\Sigma = 228$ $\quad \Sigma = 2478.00$

$M = 38.00$ $\quad \div N = 418.00$

$\sigma = 20.45$

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{20.45}{\sqrt{6-1}} = \frac{20.45}{2.24} = 9.13$$

$$t = \frac{M_1 - M_2}{\sigma_{dM}} = \frac{38.00}{9.13} = 4.16$$

Significant of the 2% level

GR2)	Word W	Wxl.43 W^1	Reasoning R	W^1-R	X	X^2
PG	37	53	50	- 3	8.66	75.00
GR	46	66	34	+ 32	20.34	413.72
KD	20	29	24	+ 5	6.66	44.36
BHa	35	50	21	+ 29	17.34	300.68
DT	28	40	51	- 11	22.66	513.48
ZR	29	41	29	+ 12	.34	.12

$\Sigma = 70$ $\quad \Sigma = 1347.36$

$M = 11.66$ $\quad \div N = 224.56$

$\sigma = 14.99$

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{14.99}{2.24} = 6.69$$

$$t = \frac{M_1 - M_2}{\sigma_{dM}} = \frac{11.66}{6.69} = 1.74$$

Significant of the 50% level

WORD AND MEMORY

Word Memory Mxl.94

GR1)	W	M	M^1	W-M^1	X	X^2
BH	35	10	19	+16	18.16	329.79
KT	34	8	16	+18	16.16	261.15
NG	70	9	17	+53	18.84	354.95
PA	54	6	12	+42	7.84	61.47
RR	62	8	16	+46	11.84	140.19
VJ	46	8	16	+30	4.16	17.31
					Σ =205	Σ =1164.86
					M =34.16	÷N =194.14
						σ =13.93

significant of the 1% level

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}} = \frac{13.93}{\sqrt{6 - 1}} = \frac{13.93}{2.24}$$

$$\sigma_M = 6.22$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{34.16}{6.22}$$

$$t = 5.49$$

Word Memory Mxl.94

GR2)	W	M	M^1	W-M^1	X	X^2
PG	37	17	33	+ 4	7.66	58.68
GR	46	8	16	+30	18.34	336.36
KD	20	8	16	+ 4	7.66	58.68
BHa	35	5	10	+25	13.34	177.96
DT	28	11	21	+ 7	4.66	21.72
ZR	29	16	31	- 2	13.66	186.60
					Σ =68	Σ =840.00
					M =11.66	÷N =140.00
						σ = 11.83

significant of the 10% level

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}} = \frac{11.83}{\sqrt{6 - 1}} = \frac{11.83}{2.24}$$

$$\sigma_M = 5.28$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{11.66}{5.28}$$

$$t = 2.21$$

REASONING AND MEMORY

GR1)	Memory M	Mx2.77 M^1	Reasoning R	$R-M^1$	X	X^2
BH	10	28	30	+ 2	10.83	117.29
KT	8	22	37	+15	2.17	4.71
NG	9	25	31	+ 6	6.83	46.65
PA	6	17	32	+15	2.17	4.71
RR	8	22	33	+11	1.83	3.35
VJ	8	22	40	+18	5.17	26.73

$\Sigma = 77$ $\Sigma = 203.44$
$M = 12.83$ $\div N = 33.91$
$\sigma = 5.82$

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{5.82}{\sqrt{6-1}} = 2.60$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{12.83}{2.60} = 4.93$$

Significant at the 1% level

GR2)	Memory M	Mx2.77 M^1	Reasoning R	$R-M^1$	X	X^2
PG	17	47	50	+ 3	2.00	4.00
GR	8	22	34	+12	7.00	49.00
ND	8	22	24	+ 2	3.00	9.00
BHa	5	14	21	+ 7	2.00	4.00
DT	11	30	51	+21	16.00	256.00
ZR	16	44	29	-15	20.00	400.00

$\Sigma = 30$ $\Sigma = 722.00$
$M = 5.00$ $\div N = 120.33$
$\sigma = 10.97$

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{10.97}{\sqrt{6-1}} = \frac{10.97}{2.24} = 4.90$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{5.00}{4.90} = 1.02$$

significant of the 50% level

NUMBER FACTOR

Group 1	Group 2	Group 1-2	Deviation from Mean	X^2
103	83	+ 20	42.83	1834.41
25	111	- 86	63.17	3990.45
12	78	- 66	43.17	1863.65
73	81	- 8	14.83	219.93
40	54	- 14	8.83	77.97
87	70	+ 17	39.83	1586.43
Σ 340	Σ 477	Σ -137	Σ	9572.84
M 56.7	M 79.5	M = 22.83	M	1595.47
				39.9

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$M = \frac{39.9}{\sqrt{6 - 1}}$$

$$= \frac{39.9}{\sqrt{5}}$$

$$= \frac{39.9}{2.24}$$

$$\sigma_M = 17.81$$

$$t = \frac{M_1 - M_2}{\sigma_d M}$$

$$= \frac{22.83}{17.81}$$

$$t = 1.28$$

Difference is significant at the 50% level

VERBAL FACTOR

Group 1	Group 2	Group 1-2	Deviation	X	X^2
46	51	- 5		30.33	919.91
48	40	+ 8		17.33	300.33
73	23	+50		24.67	608.61
60	9	+51		25.67	658.95
52	32	+20		5.33	28.41
55	27	+28		2.67	7.13
Σ=334	Σ=182	Σ=152			Σ=2523.34
M=55.66	M=30.33	M=25.333			M=420.56
					σ=20.51

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$\sigma_M = \frac{20.51}{\sqrt{6 - 1}}$$

$$\sigma_M = \frac{20.51}{\sqrt{5}}$$

$$\sigma_M = \frac{20.51}{2.24}$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$t = \frac{25.333}{9.156}$$

$$t = 2.7668$$

$$t = 2.77$$

Difference is significant at the 5% level of confidence.

SPATIAL FACTOR

Group 1	Group 2	Group 1-2	Deviation from Mean X	X^2
83	52	+31	49.16	2416.71
49	65	-16	2.16	4.67
76	95	-19	.84	.71
64	71	- 7	11.16	124.55
4	131	-127	108.84	11846.15
101	72	+ 29	47.16	2224.07
Σ=377	Σ 486	Σ =109	Σ =16616.86	
M =	M=	M=-18.16	M =2769.48	
			σ = 52.6	

Difference is significant at the 50% level

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$\sigma_M = \frac{52.6}{\sqrt{6 - 1}}$$

$$\sigma_M = \frac{52.6}{\sqrt{5}}$$

$$= \frac{52.6}{2.24}$$

$$\sigma_M = 23.4$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$t = \frac{18.16}{23.4}$$

$$t = .776$$

WORD FACTOR

Group 1	Group 2	1-2	Deviation x	x^2
35	37	2	16.16	261.15
34	46	- 12	26.16	684.35
70	20	- 50	33.84	1145.15
54	35	+ 19	4.84	23.43
62	28	+ 34	19.84	393.63
46	50	+ 4	18.16	329.79
		-		
Σ = 297	Σ = 216	Σ = 85		Σ = 2837.50
		M = + 14.16		M = 472.92
				σ = 21.74

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{21.74}{\sqrt{5}}$$

$$= \frac{21.74}{2.24}$$

$$\sigma_M = 9.71$$

$$t = \frac{M_1 - M_2}{\sigma_{DM}}$$

$$t = \frac{14.16}{9.71}$$

$$t = 1.45$$

Difference is significant at the 50% level

REASONING FACTOR

Group 1	Group 2	1-2	X	X^2
30	37	- 7	8.46	71.57
37	34	+ 3	1.54	2.37
31	24	+ 7	5.54	30.69
32	21	+11	9.54	91.01
33	51	-18	19.46	378.69
40	29	+11	9.54	91.01
Σ=203	Σ=196	Σ=+7		Σ=665.34
M=33.83	M=32.66	M=+1.46		M=110.89
				σ=10.53

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{10.53}{\sqrt{5}}$$

$$= \frac{10.53}{2.24}$$

$$\sigma_M = 4.70$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$\frac{1.46}{4.70}$$

$$t = .310$$

Difference is significant at the 50% level

MEMORY FACTOR

Group 1	Group 2	1-2	X	X
10	17	- 7	4.34	18.84
8	8	0	2.66	7.08
9	8	+ 1	3.66	13.40
6	5	+ 1	3.66	13.40
8	11	- 3	.34	.12
8	16	- 8	5.34	28.52
Σ= 49	Σ=65	Σ=-16		Σ -81.36
M= 8.16	M=10.83	M=-2.66		M =13.56
				σ=3.68

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{3.68}{2.24}$$

$$\sigma_M = 1.64$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$t = \frac{2.66}{1.64}$$

$$t = 1.62$$

Difference is significant at the 50% level

APPENDIX D

CALCULATIONS RELATED TO GROUPS THREE AND FOUR

NUMBER AND VERBAL

Number Verbal Vxl.76

GR3)	N	V	V^1	V^1-N	X	X^2
RR	40	52	92	+ 52	17.14	293.78
PA	73	60	106	+ 33	1.86	3.46
SG	79	66	116	+ 37	2.14	4.56
NA	15	57	100	+ 85	50.14	2514.02
PG	83	51	90	+ 7	7.86	61.78
VJ	87	55	97	+ 10	24.86	618.02
MW	79	56	99	+ 20	14.86	220.82

$\Sigma = 244$
$M = 34.86$

$\Sigma = 3716.46$
$\div N = 530.92$
$\sigma = 23.04$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{23.04}{\sqrt{7 - 1}}$$

$$= \frac{23.04}{2.45}$$

$$\sigma_M = 9.40$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{34.86}{9.40}$$

$$t = 3.71$$

Significant at the 2% level

Number Verbal Vxl.76

GR4)	N	V	V^1	V^1-N	X	X^2
AW	105	21	37	- 68	37.29	1390.54
BHa	81	9	16	- 65	34.29	1175.80
GR	111	40	70	- 41	10.29	105.88
HE	75	20	35	- 40	9.29	86.30
KT	25	48	84	+ 59	89.71	8047.88
KD	78	23	40	- 38	7.29	53.14
ZR	70	27	48	- 22	8.71	75.86

$\Sigma = -215$
$M = -30.71$

$\Sigma = 10935.40$
$\div N = 1562.20$
$\sigma = 39.52$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{39.52}{\sqrt{7-1}}$$

$$= \frac{39.52}{2.45}$$

$$\sigma_M = 16.13$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{30.71}{16.13}$$

$$t = 1.90$$

Significant of the 50% level

NUMBER AND SPATIAL

Space Sxl.42 Number

GR3)	S	S^1	N	S^1-N	X	X^2
RA	4	6	40	- 34	74.00	5476.00
PA	64	91	73	+ 18	22.00	484.00
SG	107	152	79	+ 73	33.00	1089.00
NA	129	183	15	+ 168	128.00	16384.00
PG	52	74	83	- 9	49.00	2401.00
VJ	101	143	87	+ 56	16.00	256.00
MW	61	87	79	+ 8	32.00	1024.00

$\Sigma N = 280$ $\Sigma = 27114.00$
$M = 40.00$ $\div N = 3873.43$
$\sigma = 62.24$

$$\sigma_M = \frac{\sigma}{N - 1} = \frac{62.24}{7 - 1} = \frac{62.24}{2.45}$$

$\sigma_M = 25.40$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{40.00}{25.40}$$

Significant of the 50% level

$t = 1.60$

Space Sxl.42 Number

GR4)	S	S^1	N	S^1-N	X	X^2
AW	83	118	105	+ 13	26.43	698.54
BHa	71	101	81	+ 20	19.43	377.52
GR	65	92	111	- 19	58.43	3414.06
HE	143	203	75	+ 128	88.57	7844.64
KT	49	70	25	+ 45	5.57	31.02
KD	95	135	78	+ 57	17.57	308.70
ZR	72	102	70	+ 32	7.43	55.20

$\Sigma N = 276$ $\Sigma = 12729.68$
$M = 39.43$ $\div N = 1818.53$
$\sigma = 42.64$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}} = \frac{42.64}{\sqrt{7 - 1}} = \frac{42.64}{2.45}$$

$\sigma_M = 17.40$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{39.43}{17.40}$$

Significant of the 10% level

$t = 2.27$

NUMBER AND WORD

GR3)	Word W	Wx3.40 W^1	Number N	W^1-N	X	X^2
RR	62	210	40	+170	72.14	5204.18
PA	54	184	73	+111	13.14	172.66
SG	38	129	79	+ 50	47.86	2290.58
NA	53	180	15	+165	67.14	4507.78
PG	37	126	83	+ 43	54.86	3009.62
VJ	46	156	87	+ 69	28.86	832.90
MW	46	156	79	+ 77	20.86	435.14

$\Sigma = 685$ $\quad \Sigma = 16452.86$

$M = 97.86$ $\quad \div N = 2350.41$

$\sigma = 48.48$

Significant of the 1% level

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{48.48}{\sqrt{7-1}} = \frac{48.48}{2.45}$$

$$\sigma_M = 19.79$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{97.86}{19.79}$$

$$t = 4.94$$

GR4)	Word W	Wx3.40 W^1	Number N	W^1-N	X	X^2
AW	35	119	105	+ 14	9.14	83.54
BHa	35	119	81	+ 38	14.86	220.82
GR	46	156	111	+ 45	21.86	281.12
HE	9	31	75	- 44	67.14	4507.78
KT	34	115	25	+ 90	66.86	4470.26
KD	20	68	78	- 10	33.14	1098.26
ZR	29	99	70	+ 29	5.86	34.34

$\Sigma = 162$ $\quad \Sigma = 10696.12$

$M = 23.14$ $\quad \div N = 1528.02$

$\sigma = 39.09$

Significant of the 50% level

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{39.09}{\sqrt{7-1}} = \frac{39.09}{2.45}$$

$$\sigma_M = 15.95$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{23.14}{15.95}$$

$$t = 1.45$$

NUMBER AND REASONING

GR3)	Reasoning R	Rx2.38 R^1	Number N	R^1-N	X	X^2
RR	33	79	40	+ 39	16.00	256.00
PA	32	76	73	+ 3	20.00	400.00
SG	44	105	79	+ 26	3.00	9.00
NA	32	76	15	+ 61	38.00	1444.00
PG	50	119	83	+ 36	13.00	169.00
VJ	40	95	87	+ 8	15.00	225.00
MW	28	67	79	- 12	35.00	1225.00

$\Sigma = 161$ $\Sigma = 3728.00$

$M = 23.00$ $\div N = 532.57$

$\sigma = 23.08$

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{23.08}{\sqrt{7-1}} = \frac{23.08}{2.45}$$

$$\sigma_M = 9.42$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{23.00}{9.42}$$

$$t = 2.44$$

Significant of the 5% level

GR4)	Reasoning R	Rx2.38 R^1	Number N	R^1-N	X	X^2
AW	13	31	105	- 74	62.00	3844.00
BHa	21	50	81	- 31	19.00	361.00
GR	34	81	111	- 30	18.00	324.00
HE	35	83	75	+ 8	20.00	400.00
KT	37	88	25	+ 63	75.00	5625.00
KD	24	57	78	- 19	7.00	49.00
ZR	29	69	70	- 1	13.00	169.00

$\Sigma = 84$ $\Sigma = 10772.00$

$M = -12.00$ $\div N = 1538.86$

$\sigma = 39.23$

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{39.23}{\sqrt{7-1}} = \frac{39.23}{2.45}$$

$$\sigma_M = 16.01$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{12.00}{16.01}$$

$$t = .75$$

Significant of the 50% level

NUMBER AND MEMORY

Memory Mx66.1 Number

GR3)	M	M^1	N	N-M^1	X	X^2
RR	8	53	40	- 13	12.29	151.04
PA	6	40	73	+ 33	33.71	1136.36
SG	9	59	81	+ 22	22.71	515.74
NA	8	53	15	- 38	37.29	1390.54
PG	17	112	83	- 29	29.29	857.90
VJ	8	53	87	+ 34	34.71	1204.78
MW	14	93	79	- 14	13.29	176.62
				Σ= 5		ΣX^2= 5432.98
				M= .71		$\div N$= 776.14
						σ = 27.86

Significant of the 50% level

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{27.86}{\sqrt{7-1}} = \frac{27.86}{2.45}$$

$$\sigma_M = 11.37$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{.71}{11.37}$$

$$t = .06$$

Memory Mx6.61 Number

GR4)	M	M^1	N	N-M^1	X	X^2
AW	2	13	105	+ 92	67.86	4604.98
BHa	5	33	81	+ 48	23.86	569.30
GR	8	53	111	+ 58	33.86	1146.50
HE	10	66	75	+ 9	15.14	229.22
KT	8	53	25	- 28	52.14	2718.58
KD	8	53	78	+ 25	.14	.02
ZR	16	105	70	- 35	59.14	3497.54
				Σ= 16.9		ΣX^2= 12766.14
				M= + 24.14		$\div N$= 1823.73
						σ = 42.71

Significant of the 50% level

$$\sigma_M = \frac{\sigma}{N-1} = \frac{42.71}{7-1} = \frac{42.71}{2.45}$$

$$\sigma_M = 17.43$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{24.14}{17.43}$$

$$t = 1.38$$

SPATIAL AND VERBAL

Space Verbal Vxl.24

GR3)	S	V	V^1	$S-V^1$	X	X^2
RR	4	52	64	-60	63.86	4078.10
PA	64	60	74	-10	13.86	192.10
SG	107	66	82	+25	21.14	446.90
NA	129	57	71	+58	54.14	2931.14
PG	52	51	63	-11	14.86	220.82
VJ	101	55	68	+33	29.14	849.14
MW	61	56	69	* 8	11.86	140.66

$\Sigma = 27$ $\Sigma = 8858.86$

$M = 3.86$ $\div N = 1265.55$

$\sigma = 35.57$

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{35.57}{\sqrt{7-1}} = \frac{35.57}{2.45} = 14.52$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{3.86}{14.52} = .27$$

Significant of the 50% level

Space Verbal Vxl.24

GR4)	S	V	V^1	$S-V^1$	X	X^2
AW	83	21	26	+57	7.86	61.78
BHa	71	9	11	+60	10.86	117.94
GR	65	40	50	+15	34.14	1165.54
HE	143	20	25	+118	68.86	4741.70
KT	49	48	60	-11	60.14	3816.82
KD	95	23	29	+66	16.86	284.26
ZR	72	27	33	+39	10.14	102.82

$\Sigma = 344$ $\Sigma = 10290.87$

$M = 49.14$ $\div N = 1470.12$

$\sigma = 38.34$

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{38.34}{\sqrt{7-1}} = 15.65$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{49.14}{15.65} = 3.14$$

Significant of the 2% level

VERBAL AND WORD

Word Wxl.93 Verbal

GR3)	W	W^1	V	W^1-V	x	x^2
RR	62	120	52	+68	32.14	1032.98
PA	54	104	60	+44	8.14	66.26
SG	38	73	66	+ 7	28.86	832.90
NA	53	102	57	+45	9.14	83.54
PG	37	71	51	+20	15.86	251.54
VJ	46	89	55	+34	1.86	3.46
MW	46	89	56	+33	2.86	8.18

$\Sigma = 251$ $\Sigma = 2278.86$
$M = 35.86$ $\div N = 325.55$
$\sigma = 18.04$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{18.04}{2.45}$$

$$= \frac{18.04}{\sqrt{7 - 1}}$$

$$\sigma_M = 7.36$$

$$t = \frac{M_1 - M_2}{\sigma_M}$$

$$\frac{35.86}{7.36}$$

$$t = 4.87$$

Significant of the 1% level

Word Wxl.93 Verbal

GR4)	W	W^1	V	W^1-V		x^2
AW	35	68	21	+ 47	16.29	265.36
BHa	35	68	9	+ 59	28.29	800.32
GR	46	89	40	+ 49	30.29	917.48
HE	9	17	20	- 3	32.71	1069.94
KT	34	66	48	+ 18	12.71	161.54
KD	20	39	23	+ 16	14.71	216.38
ZR	29	56	27	+ 29	1.71	2.92

$\Sigma = 215$ $\Sigma = 3433.94$
$M = 30.71$ $\div N = 490.56$
$\sigma = 22.15$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{22.15}{\sqrt{7 - 1}}$$

$$= \frac{22.15}{2.45}$$

$$\sigma_M = 9.04$$

$$t = \frac{M_1 - M_2}{\sigma_M}$$

$$= \frac{30.71}{9.04}$$

$$t = 3.40$$

Significant of the 2% level

VERBAL AND REASONING

Reason- Rxl.35 Verbal

GR3)	ing R	R^1	y	V-R^1	x	x^2
RR	33	45	52	+ 7	.57	.32
PA	32	43	60	+17	10.57	111.72
SG	44	59	66	+ 7	.57	.32
NA	32	43	57	+12	5.57	31.02
PG	50	68	51	-17	23.43	548.96
VJ	40	54	55	+ 1	5.43	29.48
MW	28	38	56	+18	11.57	133.86

$\Sigma = 45$

$M = 6.43$ $\quad \Sigma x^2 = 855.68$

$\div N = 126.53$

$\sigma = 11.25$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{11.25}{7 - 1}$$

$$= \frac{11.25}{2.45}$$

$$\sigma_M = 4.59$$

$$t = \frac{M_1 - M_2}{\sigma_M}$$

$$= \frac{6.43}{4.59}$$

$$t = 1.40$$

Significant of the 50% level

Reason- Rxl.35 Verbal

GR4)	ing R	R^1	V	V-R^1	x	x^2
AW	13	18	21	+ 3	12.29	151.04
BHa	21	28	9	-19	9.71	94.28
GR	34	46	40	- 6	3.29	10.82
HE	35	47	20	-20	10.71	114.70
KT	37	50	48	- 2	7.29	53.14
KD	24	32	23	- 9	.29	.08
ZR	29	39	27	-12	2.71	7.34

$\Sigma = -65$ $\quad \Sigma x^2 = 431.40$

$M = -9.29$ $\quad \div N = 61.63$

$\sigma = 7.85$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{7.85}{\sqrt{7 - 1}}$$

$$= \frac{7.85}{2.45}$$

$$\sigma_M = 3.20$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{9.29}{3.20}$$

$$t = 2.90$$

Significant of the 5% level

VERBAL AND MEMORY

Memory Mx3.75 Verbal

GR3)	M	M^1	V	$V-M^1$	x	x^2
RR	8	30	52	+22	3.00	9.00
PA	6	23	60	+37	18.00	324.00
SG	9	34	66	+32	13.00	169.00
NA	8	30	57	+27	8.00	64.00
PG	17	64	51	-13	32.00	1024.00
VJ	8	30	55	+25	6.00	36.00
MW	14	53	56	+ 3	16.00	256.00

$\Sigma = 133$ $\Sigma = 1882.00$
$M = 19.00$ $\div N = 268.86$
$\sigma = 16.40$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{16.40}{\sqrt{7 - 1}}$$

$$= \frac{16.40}{2.45}$$

$$\sigma_M = 6.69$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$t = \frac{19.00}{6.69}$$

$$t = 2.84$$

Significant of the 5% level

Memory Mx3.75 Verbal

GR4)	M	M^1	V	$V-M^1$	x	x^2
AW	2	8	21	+13	16.86	284.26
BHa	5	19	9	-10	6.14	37.70
GR	8	30	40	+10	13.86	192.10
HE	10	38	20	-18	14.14	199.94
KT	8	30	48	+18	21.86	477.86
KD	8	30	23	- 7	3.14	9.86
ZR	16	60	27	-33	29.14	849.14

$\Sigma = -27$ $\Sigma = 2050.86$
$M = -3.86$ $\div N = 292.98$
$\sigma = 17.12$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{17.12}{\sqrt{7 - 1}}$$

$$= \frac{17.12}{2.45}$$

$$\sigma_M = 6.99$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{3.86}{6.99}$$

$$t = .55$$

Significant of the 50% level

SPATIAL AND WORD

Space Word Wx2.40

GR3)	S	W	W^1	W^1-S	X	X^2
RR	4	62	149	+145	103.86	10786.90
PA	64	54	130	+ 66	24.86	618.02
SG	107	38	91	- 16	57.14	3264.98
NA	129	53	127	- 2	43.14	1861.02
PG	52	37	89	+ 37	4.14	17.14
VJ	101	46	110	+ 9	32.14	1032.98
MW	61	46	110	+ 49	7.86	61.78
				Σ=288		Σ=17642.86
				M=+41.14		÷N=2520.41
						σ=50.20

Significant of the 10% level

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{50.20}{\sqrt{7-1}} = \frac{50.20}{2.45} = 20.49$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{41.14}{20.49}$$

$$t = 2.01$$

Space Word Wx2.40

GR4)	S	W	W^1	W^1-S	X	X^2
AW	83	35	84	+ 1	12.14	147.38
BHa	71	35	84	+13	24.14	582.74
GR	65	46	110	+45	56.14	3151.70
HE	143	9	22	-121	109.86	12069.22
KT	49	34	82	+33	44.14	1948.34
KD	95	20	48	-47	35.86	1285.94
ZR	72	29	70	- 2	9.14	83.54
				Σ=-78		Σ=19268.86
				M=-11.14		÷N=2752.69
						σ=52.47

Significant of the 50% level

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{52.47}{\sqrt{7-1}} = \frac{52.47}{2.45} = 21.42$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}} = \frac{11.14}{21.42}$$

$$t = .52$$

SPATIAL AND REASONING

Space Reason- Rxl.68

GR3)	S	R	R^1	$S-R^1$	X	X^2
RR	4	33	55	- 51	62.86	3951.38
PA	64	32	54	+ 10	1.86	3.46
SG	107	44	74	+ 33	21.14	446.90
NA	129	32	54	+ 75	63.14	3986.65
PG	52	50	84	- 32	43.86	1923.70
VJ	101	40	67	+ 34	22.14	490.18
MW	61	28	47	+ 14	2.14	4.58

Σ=+83 Σ=10806.85
M=+11.86 ÷N=1543.84
σ=39.29

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{39.29}{\sqrt{7-1}}$$

$$= \frac{39.29}{2.45}$$

$$\sigma_M = 16.03$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$t = \frac{11.86}{16.03}$$

$$t = .74$$

Significant of the 50% level

Space Reason- Rxl.68

GR4)	S	R	R^1	$S-R^1$	X	X^2
AW	83	13	22	+ 61	24.72	611.08
BHa	71	21	35	+ 36	.28	.08
GR	65	34	57	+ 8	28.28	799.76
HE	143	35	59	+ 84	47.72	2777.20
KT	49	37	62	- 13	49.28	2428.52
KD	95	24	40	+ 55	18.72	350.44
ZR	72	29	49	+ 23	13.28	176.36

Σ=254 Σ=7143.44
M=3628 ÷N=1020.49
σ=31.95

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

$$= \frac{31.95}{\sqrt{7-1}}$$

$$= \frac{31.95}{2.45}$$

$$\sigma_M = 13.04$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{36.28}{13.04}$$

$$t = 2.78$$

Significant of the 5% level

SPATIAL AND MEMORY

Space Memory Mx4.67

GR3)	S	M	M^1	S-M^1	X	X^2
RR	4	8	37	- 33	60.27	3632.47
PA	64	6	28	+ 36	8.43	71.06
SG	107	9	42	+ 65	37.43	1401.00
NA	129	8	37	+ 92	64.43	4151.22
PG	52	17	79	+ 27	54.57	3032.45
WJ	101	8	37	- 64	36.43	1327.14
MW	61	14	65	+ 4	31.57	996.66

Σ = 193 Σ = 14612.00
M = 27.57 ÷N = 2087.43
σ = 45.69

Significant of the 50% level

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{45.69}{\sqrt{7-1}} = \frac{45.69}{2.45} = 18.64$$

σ_M = 18.64

$$t = \frac{M_1 - M_2}{\sigma_{dM}} = \frac{27.57}{18.64}$$

t = 1.47

Space Memory Mx4.67

GR4)	S	S	M^1	S-M^1	X	X^2
AW	83	2	9	74	29.29	857.90
BHa	71	5	23	+48	3.29	10.82
GR	65	8	37	+28	16.71	279.22
HE	143	10	47	+96	51.29	2630.66
KT	49	8	37	+12	32.71	1069.94
KD	95	8	37	+58	13.29	176.62
ZR	72	16	75	- 3	47.71	2276.24

Σ = 313 Σ = 7260.40
M = 44.71 ÷N = 1037.20
σ = 32.21

Significant of the 2% level

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{32.21}{\sqrt{7-1}} = \frac{32.21}{2.45} = 13.14$$

σ_M = 13.14

$$t = \frac{M_1 - M_2}{\sigma_{dM}} = \frac{44.71}{13.14}$$

t = 3.40

WORD AND REASONING

GR3)	Word W	Vxl.43 W^1	Reasoning R	W^1-R	x	x^2
RR	62	89	33	+56	24.29	590.00
PA	54	77	32	+45	13.29	176.62
SG	38	54	44	+10	21.71	471.32
NA	53	76	32	+44	12.29	151.04
PG	37	53	50	+ 3	28.71	824.26
VJ	46	66	40	+26	5.71	32.60
MW	46	66	28	+38	6.29	39.56

$\Sigma = 222$ $\Sigma = 2285.40$
$M = 31.71$ $\div N = 326.48$
$\sigma = 18.07$

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{18.07}{\sqrt{7-1}} = \frac{18.07}{2.45}$$

$$\sigma_M = 7.38$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

Significant of the 1% level

$$t = \frac{31.71}{7.38}$$

$$t = 4.30$$

GR4)	Word W	Vxl.43 W^1	Reasoning R	W^1-R	x	x^2
AW	35	50	13	+37	22.00	484.00
BRa	35	50	21	+29	14.00	196.00
GR	46	66	34	+32	17.00	289.00
HE	9	13	35	-22	37.00	1369.00
KT	34	49	37	+12	3.00	9.00
KD	20	29	24	+ 5	10.00	100.00
ZR	29	41	29	+12	3.00	9.00

$\Sigma = 105$ $\Sigma = 2456.00$
$M = 15.00$ $\div N = 350.86$
$\sigma = 18.73$

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{18.73}{\sqrt{7-1}} = \frac{18.73}{2.45}$$

$$\sigma_M = 7.64$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

Significant of the 50% level

$$t = \frac{15.00}{7.64}$$

$$t = 1.96$$

WORD AND MEMORY

Word Memory Mxl.94

GR3)	W	M	M^1	W-M^1	X	X^2
RR	62	8	16	+46	17.57	308.70
PA	54	6	12	+42	13.57	184.14
SG	38	9	17	+21	7.43	55.20
NA	53	8	16	+37	8.57	73.44
PG	37	17	33	+ 4	24.43	596.82
VJ	46	8	16	+30	1.57	2.46
MW	46	14	27	+19	9.43	88.92

$\Sigma = 199$ $\Sigma = 1309.68$
$M = 28.43$ $\div N = 187.10$
$\sigma = 13.68$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{13.68}{\sqrt{7 - 1}}$$

$$= \frac{13.68}{2.45}$$

$$\sigma_M = 5.58$$

$$t = \frac{M_1 - M_2}{\sigma_{DM}}$$

$$= \frac{28.43}{5.58}$$

$$t = 5.09$$

Significant of the 1% level

Word Memory Mxl.94

GR4)	W	M	M^1	W-M^1	X	X^2
AW	35	2	4	+33	19.00	361.00
BHa	35	5	10	+25	11.00	121.00
GR	46	8	16	+30	16.00	256.00
HE	9	10	19	-10	24.00	576.00
KT	34	8	16	+18	4.00	16.00
KD	20	8	16	+ 4	10.00	121.00
ZR	29	16	31	- 2	16.00	256.00

$\Sigma = 98$ $\Sigma = 1707.00$
$M = 14.00$ $\div N = 243.86$
$\sigma = 15.62$

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{15.62}{\sqrt{7 - 1}}$$

$$= \frac{15.62}{2.45}$$

$$\sigma_M = 6.37$$

$$t = \frac{M_1 - M_2}{\sigma_{DM}}$$

$$= \frac{14.00}{6.37}$$

$$t = 2.20$$

Significant of the 10% level

REASONING AND MEMORY

GR3	Memory M	x2.77 M^1	Reasoning R	$R-M^1$	X	X^2
RR	8	22	33	+11	1.71	2.92
PA	6	17	32	+15	5.71	32.60
SG	9	25	44	+19	9.71	94.28
NA	8	22	32	+10	.71	.50
PG	17	47	50	+ 3	6.29	39.56
VJ	8	22	40	+18	8.71	75.86
MW	14	39	28	-11	20.29	411.68
				Σ=65		Σ=657.40
				M =9.29		÷N =93.91
						σ=9.69

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{9.69}{\sqrt{7-1}} = \frac{9.69}{2.45}$$

$$\sigma_M = 3.95$$

$$t = \frac{M_1 - M_2}{\sigma_{dM}}$$

Significant of the 10% level

$$t = \frac{9.29}{3.95}$$

$$t = 2.35$$

GR4	Memory M	x2.77 M^1	Reasoning R	$R-M^1$	X	X^2
AW	2	6	13	+7	2.00	4.00
BHa	5	14	21	+7	2.00	4.00
GR	8	22	34	+12	7.00	49.00
HE	10	28	35	+7	2.00	4.00
KT	8	22	37	+15	10.00	100.00
KD	8	22	24	+2	3.00	9.00
ZR	16	44	29	-15	20.00	400.00
				Σ=35		Σ=570.00
				M =5.00		÷N =81.73
						σ=9.04

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}} = \frac{9.04}{\sqrt{7-1}} = \frac{9.04}{2.45}$$

$$\sigma_M = 3.69$$

$$t = \frac{M_1 - M_2}{\sigma_{dM}}$$

Significant of the 50% level

$$t = \frac{5.00}{3.69}$$

$$t = 1.35$$

NUMBER FACTOR

Group 3	Group 4	3-4	Deviation from Mean X	X^2
40	105	-65	52.29	2734.24
73	81	- 8	4.71	22.18
79	111	-32	19.29	372.10
15	75	-60	47.29	2236.34
83	25	+58	70.71	4999.90
87	78	+ 9	21.71	471.32
79	70	+ 9	21.71	471.32
Σ=456	Σ=545	Σ=89		Σ=11307.40
		M = 12.71		$\div$M = 1615.34
				σ=40.19

Difference is significant at the 50% level

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$\sigma_M = \frac{40.19}{\sqrt{7 - 1}}$$

$$= \frac{40.19}{\sqrt{6}}$$

$$= \frac{40.19}{2.45}$$

$$\sigma_M = 16.34$$

$$t = \frac{12.71}{16.34}$$

$$t = .778$$

VERBAL FACTOR

Group 3	Group 4	Group 3-4	Deviation from mean X	X^2
52	21	+ 31	1.14	1.30
60	9	+ 51	21.14	446.90
66	40	+ 26	3.86	14.90
57	20	+ 37	7.14	50.98
51	48	+ 3	26.86	721.46
55	23	+ 32	2.14	4.58
56	27	+ 29	.86	.74
Σ=397	Σ=188	Σ=209		Σ=1240.86
		M =29.86		M =177.27
				σ= 13.31

Difference is significant at the 1% level

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{13.31}{\sqrt{6}}$$

$$= \frac{13.31}{2.45}$$

$$\sigma_M = 5.43$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$= \frac{29.86}{5.43}$$

$$t = 5.50$$

SPATIAL

Group 3	Group 4	3-4	Deviation from mean X	X^2
4	83	-79	70.43	4960.38
64	71	- 7	1.57	2.46
107	65	+42	50.57	2557.32
129	143	-14	5.43	29.49
52	49	+ 3	11.57	133.86
101	95	+ 6	14.57	212.28
61	72	-11	2.43	5.90
Σ =518	Σ =578	Σ =60	Σ =7901.69	
		M =8.57	M =1128.81	
			σ =33.60	

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{33.60}{\sqrt{7 - 1}}$$

$$= \frac{33.60}{2.45}$$

$$\sigma_M = 13.71$$

$$t = \frac{8.57}{13.71}$$

$$t = .625$$

Difference is significant at the 50% level

WORD

Group 3	Group 4	Group 3-4	Deviation from mean X	X^2
62	35	+27	11.71	137.12
54	35	+19	3.71	13.76
38	46	- 8	23.29	542.42
53	9	+44	28.71	824.26
37	34	+ 3	12.29	151.04
46	20	+26	10.71	114.70
46	50	- 4	19.29	372.10
Σ=336	Σ=229	Σ=+107		Σ=2155.40
		M=15.29		M =307.91
				σ =17.54

Difference significant at the 10% level

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{17.54}{\sqrt{7 - 1}}$$

$$= \frac{17.54}{2.45}$$

$$= 7.16$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$t = \frac{15.29}{7.16}$$

$$t = 2.14$$

REASONING FACTOR

Group 3	Group 4	3-4	Deviation from mean X	x^2
33	13	+ 20	10.57	111.72
32	21	+ 11	1.57	2.46
44	34	+ 10	.57	.32
32	35	- 3	12.43	154.50
50	37	+ 13	3.57	12.74
40	24	* 16	6.57	43.16
28	29	- 1	10.43	108.78
Σ=259	Σ=193	Σ=66	Σ= 433.68	
M=	M=	M=9.43	M= 61.95	
			σ= 7.87	

Difference is significant at the 5% level

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$= \frac{7.87}{\sqrt{7 - 1}}$$

$$= \frac{7.87}{2.45}$$

$$\sigma_M = 3.21$$

$$t = \frac{M_1 - M_2}{\sigma_{d\,M}}$$

$$t = \frac{2.43}{3.21}$$

$$t = 2.94$$

MEMORY FACTOR

Group 3	Group 4	3-4	Deviation from Mean X	X^2
8	2	+ 6	4.14	17.14
6	5	+ 1	.86	.57
9	8	+ 1	.86	.57
8	10	- 2	3.86	14.90
17	8	+ 9	7.14	50.98
8	8	- 0	1.86	3.46
14	16	- 2	3.86	14.90
		Σ=13		Σ=102.52
		M=+1.86		M=14.65
				σ=3.83

Difference is significant at the 50% level

$$\sigma_M = \frac{\sigma}{\sqrt{N - 1}}$$

$$\sigma_M = \frac{3.83}{\sqrt{7 - 1}}$$

$$= \frac{3.83}{2.45}$$

$$\sigma_M = 1.56$$

$$t = \frac{M_1 - M_2}{\sigma_{dM}}$$

$$= \frac{1.86}{1.56}$$

$$t = 1.19$$