THE PSYCHOLOGY OF
INDIVIDUAL DIFFERENCES

by

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SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS

in the

GRADUATE SCHOOL

of the

UNIVERSITY OF MISSOURI

1915

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TABLE OF CONTENTS

	Page
I. Introduction	1
II. The Problem	3
III. A Brief Review of the Literature on Individual Differences	5
IV. The Treatment of the Problem	18
V. Description of the Tests Used	25
VI. Tables Showing the Results	76
VII. Treatment of Results - Conclusions ...	100
VIII. Bibliography	110

Introduction.

Although the subject of individual differences is comparatively new from the standpoint of experimental treatment, it is a theme which has been pondered over many times in practical life, from the very beginning of time. Whenever men are confronted with the problem of choosing from a great number of individuals one who can accomplish a task most efficiently, the question of individual differences immediately arises. That every man differs from his neighbor is a fact universally recognized. But what means have we at present of determining these differences? The measuring rod commonly applied is "general impression", and this is usually reliable if we have the time to form the proper impression. But it takes time. If the world of business had a few mental tests, a reliable measuring rod of an individual's ability, what a saving of time and trouble it would be.

Before psychology^{ists} can secure a patent on, and turn over to the business world, such a measure it is necessary for them to determine this fact: "If you measure one function of mind, what do the results tell you about other functions." This must be decided for the very obvious reason that no government or other employer of men will have time to test all the mental functions of the individuals seeking employment. In carrying out an experiment to solve such a problem as the one just mentioned, a great deal of time and patience is required both

of the experimenter and the subjects.

To Dr. W. H. Pyle, Associate Professor of Educational Psychology in the University of Missouri, I am particularly indebted for the most valuable assistance in securing the subjects and guiding the experiment with many helpful suggestions; also to Miss Harriette Simpson, Miss Anna Wells, and Miss Erma Waltner who assisted in working out and checking the many correlations.

The Problem.

When the science ^{study} of psychology was still in its infancy, and the main object of study was to establish general laws, the individual variations, which were discovered in investigations, were regarded by the experimenters as factors which could be ignored. As the science developed, however, these individual differences came to be studied for their own value, and they now have a literature of their own. This will be seen by a glance at the bibliography in William Stern's "Differentielle Psychologie". Individual psychology employs the same methods of procedure as general psychology, but it extends these and reforms them according to its own requirements.

Naturally the first step in individual psychology was the enumeration of the various individual differences. This part of the task was accomplished by the earliest workers in the field. The trouble has been that until recently the entire study consisted of mere enumeration, the relation of one difference to another being wholly neglected.

The fundamental individual differences can, according to Meumann, be classified according as they appear in the intellectual, the emotional, or the volitional life. [It is a part of the first class - the intellectual - that we are concerned with in this paper, namely, individual differences in the ^{higher} ~~fundamental~~ functions. One of the chief tasks is to discover the inner relation of these differences in the same

individual, and the dependence of one type of difference upon another.

~~Each individual has~~^{One} often wonder^sed in just what respects he differs intellectually from his fellows. In attempting to solve this problem, one of the most pressing questions that presented itself to psychologists for an answer was: Does the difference between normal individuals depend upon a difference in a 'general ability', or is it due to an unequal distribution of specific abilities? Part of this paper is concerned with these two questions. The aim of this experiment is (1) to discover what individual differences exist between normal adults of approximately the same age, social status, nationality and educational training; and (2) to find out by an examination of the data collected in solving the first part of the problem the exact nature of these differences. This involves the problem of whether each individual has certain differences - which means certain mental functions - that hang together, or possesses a general ability in every mental function that enables him to do one thing about as well as another.

II.

A Brief Review of the Literature on Individual Differences.

My survey of the previous treatment of the problem of individual differences will be unusually brief for the reason that the work done in this field has reached a point where summarizing results is a comparatively easy task. I shall endeavor to give a brief exposition of the chief theories held by psychologists who have worked in the field and treat briefly the contributions made to each theory.

Three distinctly different theories have been evolved:

1. The Theory of Specific Abilities. The psychologists who have championed this doctrine hold the view that ability in any act depends upon a complex system of factors, and that a correlation between two acts of any kind merely shows to what degree the factors going to make up one act happen to be identical with, or very closely associated with, the factors demanded in the performance of the other act. This theory is the oldest of the three. It 'smacks' of ^cfaulty psychology. This was Thorndike's original view; Norsworthy also held it.

2. The Theory of 'General Ability'. According to this theory all acts depend upon one and the same general common factor, i.e., each individual has a certain fund of energy or 'intelligence' or 'ability' which will aid him in the performance of any and every act. Of course the supporters of this view add as a corollary to it the statement that each act demands certain specific factors which differ

from the ones supplied by the general ability. This means that all kinds of performances should give ^{positive} correlation with all other performances, taken singly or as a group; whether the correlation is high or low depends upon the extent to which the acts being correlated demanded the use of the common factor or 'intelligence' or 'ability'. It is this view that is vigorously supported by the British school of psychologists.

3. The 'faculty', 'type', or 'level' theory. This theory lies between the two extremes mentioned above. The view supported here is, that an individual who does a certain performance well can also do certain other related performances well. In other words, certain mental functions hang together, but one set of functions exclude certain others. The psychologists upholding this view assume a high correlation between all performances belonging exclusively to the same 'faculty' or 'level' and absence of or a low correlation between performances belonging wholly to different 'types' or 'levels'. Thorndike is the ablest supporter of this theory. He believes, however, as does Norsworthy, that there are no types within one 'level' of mind. It is his opinion that people differ in one 'level'; say association, the difference is due to the fact that the individuals concerned possess different amounts of the same thing and not to the fact that there are different types of association. This view, of course, approaches in a way the theory of 'general ability'.

The question which naturally arises next is, How do the supporters of each of the three theories attempt to estab-

lish their views? In any test which measures the quality or quantity of a performance, we can secure a rank-order of the individuals taking the test; but does this obtained order tell us anything about the intelligence of the people examined? The method used by most of the experimenters in this field has been to require several performances of the same individual..These performances are usually meant to test different aspects of mind. The individuals are then ranked in their order for each of the several performances. It then remains to compare the several rank-orders. This is done by the method of correlation.

Perhaps a pause at this point to give a brief explanation ^{of} ~~by~~ what we mean by the term correlation would not be amiss. Of course I shall not attempt to develop the method of calculating correlation. A correlation between the results of two tests ranges from plus 1 through zero to minus 1. If the correlation is plus 1 it means that the individual who is best in the first test is also best in the second test, and the individual who is poorest in the first test is also poorest in the second test, i.e., there is complete correspondence or correlation throughout the tests. But let us suppose that the individual who ranks first in the first test ranks second in the second test, and the individual who ranks lowest in the first test, ranks, say, third from the lowest in the second test, etc. This would mean that the correspondence is fairly good and the correlation would probably be about .70 or .80. ~~often~~ ^{often} we secure what we call an inverse or negative correlation.

This is the case when most of the individuals who are good in one test are poor in the other. A perfect inverse correlation is obtained in a case where the individual who is best in one test is poorest in the other, and the person who is second best in one test, is second poorest in the other, etc. By zero correlation we mean that we cannot predict what an individual will do in the second test by the mark he makes in the first test. If he is best in one test, he may be best, poorest, or medium in the other - we cannot tell.

But let us return to the problem. As we stated above, all the different rank-orders can be brought into correlation with one another. Of all the possible correlations three particular kinds have been employed by most authors: (1), correlation of test with test: (2) correlation of estimates with school performance (by estimate here, I mean a careful teacher's careful estimate of a student's general intelligence as indicated by his reactions in solving life's problems); (3) correlation of test with estimate. The chief work in correlations of tests with tests has been done by English experimenters under the general direction and guidance of Spearman. Among this class we might name Abelson, Brown, Burt, and Hart. / It is the belief of these men that if the pupils of a class have been tested by means of several different tests and the resulting rank-orders show mutually high correlations, this is a sign that the ability demanded in the tests depends upon a common factor, which they call by different names, such as 'general intelligence' or 'general ability' or 'intellective ener-

gy'. According to this theory pupil number one ranks high in every test taken, while pupil number two has a low rank in each test. This we can readily see, for, if the theory of specific abilities functioned, pupil number one might have a high rank in one test, a medium rank in another and a low rank in a third, and pupil number two might show the same variance. These experimenters have found extraordinarily high correlation in several instances and hence it is their claim that such a thing as 'general intelligence' really exists and that the particular degree in which one person possesses this 'general intelligence' can be definitely determined by the use of tests that correlate with one another in a high degree. The results of the work of the men mentioned above has been practically identical. They differ only in that they use different subjects for their experiments and vary the methods slightly. Their general method of attacking a problem was to give a series of tests, rank the individuals in these tests and correlate test with test. The chief tests used were: tapping; crossing out rings; crossing out sets of dots, memory for sentences, memory for name of objects, memory for commission, comparison of lines, interpretation of pictures, imputed intelligence, spot pattern, mirror writing and drawing, discrimination of length of lines, discrimination of weight and of touch; card sorting, alphabet finding, immediate memory for (a) concrete words, (b) abstract words, (c) nonsense syllables; dotting irregular dots; completion tests;

school marks; and crossing out letters. Burt states very well the reason for selecting the tests in each case. He says, "The Tests were psycho-~~ph~~ysical tasks selected as readily and rapidly yielding comparable quantitative results, and as standing in possible functional relationship with the capacity called 'General Intelligence'". In the intercorrelation of the tests the similarity between the performances was so marked that a specially high correlation figure resulted. Arguing from this, Abelson says "the degree of similarity indicated by the 'faculties current in lay psychology, such as memory, judgment, discrimination, etc. is quite insufficient. It is obvious that the cause of the observed correlation must be looked for elsewhere". This cause the English psychologists term 'general ability', and state that its grade can be experimentally determined.

As a more definite and comprehensive proof of these statements, Hart and Spearman offer the following calculations. They took as a basis for their experiment the results of tests given by several men who had worked in the field of individual psychology. They arranged the correlations between tests according to the method used in the following table:

	Dot- ting	Alpha bet	Sort- ing	Spot Pattern	etc.
Dotting		77	67	57	etc.
Alphabet	77		74	59	etc.
Sorting	67	74		45	etc.
Spot Pattern	57	59	45		etc.
etc.					

Their criterion consisted simply in the correlation between one column of figures and another; it is the correlational coefficient between the two series of correlational coefficients; obviously, this is just as easy to work out as between any two other series of values. They then 'pooled' (took the average of) the correlations between the different pairs of columns and based their considerations on these values. They also figured the probable error in each case and corrected accordingly.

The reason for selecting this criterion is given in the following statements: "No reliable conclusions can be expected from picking out - as some authors have done - one or two particular coefficients from the table to serve as sole basis of argument. The most obvious method would be to devise as criterion some direct function of all the coefficients in the table. We have, however, chosen a somewhat different course. It seemed desirable to retain the power of noting whether the whole table obeyed the same

law or different parts of it behaved differently. For these reasons, our criterion was based upon singling out from the table any pair of columns of coefficients (of course rows would come to the same thing). For illustration let us refer to the table on the preceding page. Suppose we select sorting and spot pattern as the pair of columns to be correlated; one coefficient in each column has no correspondent in the other and therefore has to be omitted. The columns to be correlated would be as follows:

Sorting	Spot Pattern
67	57
74	59
etc.	etc.

Since the intercorrelation of tests and columns and the 'pools' resulting from a combination of columns was in all instances very high. They came to the conclusion that such a thing as a 'general ability' exists and that the degree of this ability can be approximately ascertained by experiment.

In criticism of this Stern says, "We can agree with the first of these conclusions". (i.e., that a 'general ability' exists) "We have already alluded frequently..... to the 'general' and 'formal' character of intelligence, whose influence is operative in activities of wildly different character. Of course, we must admit that this influence of intelligence is never more than approximately uniform that within the 'general intelligence' of every person there must exist certain specially strong and certain specially weak points, so that a truer picture of the

total intelligence of the individual is given by the idea of a mutual balancing or compensation of different capacities than by the idea of their equality or correspondence."

But just here does the value of Spearman's method for testing of intelligence become dubious. If we select four or five tests that show very high intercorrelations in order to use their totals as a measure of intelligence, there exists the danger that we may be testing by them only a very restricted portion of the field of intelligence and leaving entirely out of consideration other compensatorily important portions. If, on the other hand, we keep the idea of compensation in mind and therefore assemble together tests that correlate only moderately with one another, we have ~~no~~ way of knowing which combination of tests does actually secure that mutual balance on the basis of which as a whole a more correct quantitative expression of intelligence ~~is~~ to be yielded".

Stern then says that his objection might be answered by the statement that tests which show a high correlation can be selected from such divergent realms of mental life that the danger of testing only a very restricted portion of the field of intelligence can be avoided. But as opposed this he writes: "Attention must be directed to a matter that has not been sufficiently heeded heretofore. All test investigations, even if they pertain to the most widely different realms of mental life, have this in common that they are experimental modes of procedure, so that all put the examinee into the same mental condition - that of

being a subject. And this involves not only very definite adjustments of attention, of mood, etc., but also in particular the habit of mere reacting, of taking at a given moment a receptive attitude toward a problem set from without. Consequently, spontaneous intelligence is excluded by the conditions of the experiment; there is not involved that intelligence that sets its own problems, that thinks out things independently beyond what is immediately given, that anticipates explanations by questions, and that in the real situations of life quickly works out the best way of confronting a situation. And we have absolutely no way of knowing whether we can infer from the reactive intelligence however many tests of it we make, to this spontaneous intelligence. It is possible that certain tests or certain combinations of tests have a fairly high correlation with the spontaneous intelligence, but that is something that can not be determined from the experiments."

"Hence," he concludes, "the mere comparison of tests with one another affords us neither a clear insight into the necessary compensations, nor a decision as to the symptomatic value of the testing; rather must we seek the means of gauging the tests in some criterion that lies outside of experiment. Such a criterion is supplied by the estimation of the pupils made by the teacher."

[The chief advantage of estimating intelligence by the teacher over experimental testing of intelligence, Stern thinks, lies in the fact that it is based upon a longer and wider acquaintance with the pupil. The teacher has noticed the pupil in every phase of life and should have a much

broader range of information on which to base his judgment of the pupil's intelligence than has the experimenter [who as Stern says,] has merely taken a half hour's time to record the response of the child to a small number of tests. Of course the business of estimating must be carefully carried out. He suggests that the only way to do it properly is to have teachers specially trained and specially gifted in psychology and instructed specifically in the nature of the task demanded of them. According to his scheme the children would be ranked in groups and later those in the groups would be ranked. In comparing this estimation with scholastic records, Stern finds that when ~~an~~ estimation of intelligence is made with special thoroughness and caution, there exists only a moderate degree of correlation between it and school efficiency.

Hence we can readily see that it is not an easy matter to estimate intelligence [as Stern would have us know,] but the goal is worth all the trouble entailed in reaching it, for it is, (as he would let us know,) the only safe measure of intelligence. [However, he sees a possibility for the future of experimental test.] It is his opinion that if we use tests that will produce a high figure when correlated with estimated intelligence, we may finally be able to secure just the proper combination of tests. He would designate as proper that combination of tests which had a high correlation with estimated intelligence; in other words, estimated intelligence is the measuring rod for all other tests.

This "skillfully combined system of tests" would be tests "that correlate less with one another than each one of them correlates with estimated intelligence, and that combination whose amalgamated rank-order shows the highest and most constant correlation with estimated intelligence is the system of tests that we seek."

Let us now return once more to Spearman's conclusions. For the purpose of comparing them with Thorndike's view, I shall state them as given by Spearman himself. He says, after stating that a 'general ability' exists and that its degree can be measured by experimental methods, "it was never asserted.... that the General Factor prevails exclusively in the case of performances too alike: it was only said that when this likeness is diminished (or when the resembling performances are pooled together), a point is soon reached where the correlations are still of considerable magnitude, but now indicate no common factor except the General one. The latter, it was urged, produces the basal correlation, while the similarities merely superpose something more or less adventitious. Up to the present, however, these similarities seem to have exercised surprisingly small influence." This was written in defence of his article that had been published a short time before. In commenting on this article in his "Educational Psychology" Thorndike says: "The view, so stated, (referring to Spearman's view) does not differ from the view to be presented in this volume, save in the intimation in the

last sentence that the 'similarities' other than in the general factor's strength, are of trivial effect in comparison with it." We can see from this that Thorndike attaches a great deal of importance to the factors other than the 'general factor' that go to make up a performance. It is my opinion that he would agree with Simpson who says in the conclusion of his "Correlations of Mental Abilities": "We find justification for the common assumption that there is close inter-relation among certain mental abilities, and consequently a something that may be called 'general mental ability' or 'general intelligence'; and that on the other hand certain capacities are relatively specialized, and do not necessarily imply other abilities except to a very limited extent."

III.

The Treatment of the Problem.

There are, as we have seen in the preceding section three different theories which have been offered as explanatory of the facts of individual psychology. The method of arriving at these explanations has been to give a series of selected tests and judge by the individuals' performances, which theory is the true one. Stern, however, attacks the problem in a slightly different manner since he thinks that the most reliable way to determine general intelligence is by the carefully prepared estimate of a teacher specially trained for this sort of work.

The procedure in this experiment has been to give a series of twenty selected tests (usually four or five of a kind), correlate each test with every other test and confront the theories with the facts thus obtained. In doing this I have utilized (in addition to giving other tests) the method recommended by Stern in my test called 'Imputed Intelligence'. Just what facts are required by each theory I shall discuss in the concluding sections of ~~the experiment~~ *this paper*

There were nine subjects, three men and six women, in the main experiment. All of them were seniors and post-graduates of approximately the same age, social status and educational training. I shall refer to them as Mr. A, Mr. B, Miss C, Mr. D, Miss E, Miss F, Miss G, Miss H, and Miss I. Miss G and Miss H are sisters; Miss G is the elder. Mr. A and Miss H were

selected as specially good students. This was based on scholastic record plus marks made in some group mental tests given to a psychology class. By the same standards Miss C, Miss F, Miss G and Miss I were selected as being good students. Mr. B, Mr. D, and Miss E were chosen as representative of the poor type (as shown by the measures mentioned above).

Each test was personally conducted by the experimenter in a laboratory room apart from all distraction. The tests were given to only one subject at a time. No subject spent more than forty minutes at one testing ^{period} (except in one or two rare instances where work which had been accomplished by the good students in much less time required more than forty minutes of the poorer peoples' time). Each subject was tested daily, five or six days out of the week until the series of tests were completed.

The utmost care was used to make the experiments uniform. Unless the conditions were such that a test could be uniform, it was not given. Several whole tests were thrown out because of lack of uniformity. The ones listed in the following section, however, were carried out under as nearly uniform conditions as it is possible to secure.

In scoring the results of the tests, I have given

in each case two tables. The first table contains the original marks, the second table, the results of the tests as a whole reduced to a scale where the average performance received the mark of 50. This was done by means of slide-rules, - the Mannheim in direct figures and the Weiss Inverse scale (used because of its simplicity) in the tests where low figures mean high efficiency. This second table enables one to tell at a glance whether or not a certain subject is above or below the average in a given test; e.g., if Mr. A makes 52 in a logical memory test, we know that he is above the average, while if Miss E's mark is 48 we know she is below the average of the group.

In all my correlations between tests (and there were two hundred of them) I have used the figures given in the tables where the average mark is 50. My original plan was to rank the subjects in each test and correlate the ranks thus secured. I believe, however, that the method I have adopted has a decided advantage over the rank method in that it not only indicates the rank of each subject, but shows just how far subject No. 1 is above No. 2, etc. Much time has been spent on the correlations, but each one has been worked through at least twice, and by a different person each time.

The formula used in correlating is the one given by Pearson. My correlations are all the raw figures;

no corrections have been made. I believe, with Simpson, that the labor spent upon the correction of the Pearson coefficients of correlation by means of the Spearman's formula is not justified by the gain in accuracy secured. It has been my hope to obtain greater results by getting as accurate and reliable records as possible of each individual's ability in each test, so that correction on an extensive scale would not be necessary, ~~since in any case correction is valid only when the reliability of the records themselves is fairly high.~~

In the following experiment the correlations of each test with all the other tests have been arranged in columns. I have not attempted to correlate each column with every other column, but have correlated enough pairs of columns to indicate what might be expected if all the correlations had been made. I have also found the average correlation of each test with every other test. This gives me abundant data with which to confront the three theories mentioned in the first part of this section.

The question which naturally arises next is what results are required to prove or disprove each of the three theories. The theory of specific ability or "non-focal" theory, which was formerly held by Thorndike, asserts that each ability is entirely independent of every other ability. Hence there would be no correspondence

or correlation between tests or 'columns' of tests. In other words it is plain that if this theory is the correct one, the correlations between columns, as well as those between tests, would approach zero.

We need quite different results to accord with the theory of 'types' or 'levels' which is often called the 'multifocal' theory. Thorndike assumes that there are three 'levels' (1) sensitivity, (2) association, and (3) dissociation. In order for this theory to stand it would be necessary for the tests within one 'level' to correlate very high with one another, but to correlate low with any test taken from another 'level'. Hence we can plainly see that the average correlation of one test with nineteen others, which have been taken from all three 'levels', would have to be rather low if this theory is the true one.

Still different results are required to prove the theory of a general factor. In the first place each test must correlate comparatively high with every other test. This would mean a high average correlation. If we wish to carry the proof a step further, we might correlate the columns of correlations one with another. The figures resulting from these operations should when corrected approach unity. It is our purpose to look these theories squarely in the face with the results obtained from the twenty different tests, which have been given. These re-

sults should be valuable, for the tests used measure most of the important intellectual aspects. One test of a kind has not been considered sufficient to produce reliable results. Hence I have given four or five of each kind. Each subject has been examined with one hundred and seven distinctly separate tests. This figure does not include the 'imputed intelligence' or the 'scholastic record'. Of course the experiment would be more valuable if the number of subjects had been greater. Still a close examination of even two individuals would indicate whether the mental functions are entirely separate, or certain functions hang together, or all the functions hang together. I mean to say, that if one of these three theories is true, an extensive examination of a small group of people will produce sufficient evidence to prove the fact. Most of the experimenters in the field of individual differences, have employed a method which differs from the one used in this experiment in that they gave comparatively few tests to a larger number of people. It is my opinion that of the two methods, the one used in this experiment is the most reliable, for, in order to solve the problem it is absolutely necessary for us to give a sufficient number of reliable tests to examine the important mental functions. Of course the best method is to give an extensive number of tests to a large number of subjects. The man whose

time permits him to carry on the experiment in this way is particularly fortunate, for his results will be most reliable. It is my hope to carry on this experiment in this way in the near future.

Description of the Tests Used.

1. Logical Memory.

Object.- The object of this test is to determine the individual's immediate memory for ideas. It is a test of one's memory for meaningful material.

Method.- Four logical memory tests were used. The tests were arranged in order of difficulty, the first test being an easy narrative and the last a rather difficult description. The selection to be reproduced was read slowly and distinctly. After the reading the individual wrote down all the material he could remember. Only one test a day of this kind was given. Since this performance is not meant to test the individual's speed in writing, the time of reproduction was not limited, except that the paper was taken up when the subject seemed to have written all that he could recall. The instructions to all the subjects were the same: "I shall read you a story entitled _____ . After I have read it you are to write down all that you remember of it. You need not use the exact words I read unless you wish. Let your object be to reproduce every idea of the selection in detail. Try to remember as much as possible and write down all that you remember. Bear in mind that I want not only the main facts, but every single detail".

The four tests used were as follows:

Logical Memory Test No. 1.

The Juggler.

A poor / juggler,/ Jean,/ who wanders / from place to place / and amuses / country / people / by his tricks / and songs,/ finds it difficult / to make / even / a precarious / living./ He reaches Paris,/ and finds / that his "art"/ has no attraction / for the more sophisticated / population / of the gay / capital./ He sings / a drinking / song / before a crowd / of artisans / and students,/ and is severely / upbraided / by a monk / from a neighboring / monastery. The monk / persuades him / to enter the convent / and become one of them./ Jean's faith / is simple,/ but / he is attracted / by the prospect / of an easy life / plus / certain / salvation / for his soul./

As a monk / Jean / finds himself destitute / of resources./ He cannot / at the celebration / of the Feast / of the Virgin,/ show his devotion / by bringing / any suitable / offering./ His brother monks / paint,/ carve,/ compose,/ but he,/ a juggler / by profession,/ can do nothing / fit / and worthy / of the sacred / ceremony./ He is dejected / and humiliated./ Suddenly / he doffs / his robe,/ puts on / his old / cap / and bells,/ and begins to perform / his tricks / of jugglery / before the altar./ This is his way / of worshiping / the Virgin./ The monks / come trooping in /-horrorified / at sacrilege./ They are about to drive him / out of the chapel / when,/ lo!/ a miracle / occurs./ The statue / of the Virgin / moves./ There is life / in it./ The Virgin /

opens her arms,/ bends forward / and clasps / the humble /
 but sincere / follower./ Celestial / voices / are heard,/
 a halo / encircles / the juggler's / head/and he dies /
 in ecstasy / and adoration / while the monks / kneel / and
 pray./

Logical Memory Test No. 2.

The Opium Fiend.

Charles / Browne,/ a government / chemist / who loves
 his work / and his home,/ is living happily/ with his wife /
 Gertrude / and little son,/ "Robbie"./ Touring thru / the
 country / comes one Richard / Manteaux,/ an operative mana-
 ger / from New York / and a former / acquaintance of Browne's,/
 Brown / invites him into his home,/ where Manteaux meets /
 and becomes enamored of Gertrude./ He leaves his diamond
 stud / lying on the table,/ that he may have an excuse to re-
 turn ,/ which, later he does / in the absence of her husband./
 The apparent / opulence / and easy manners of Manteaux / fas-
 cinate Gertrude / and bring to her a wave of discontent./
 This is increased / when, on hearing her sing,/ the impre-
 sario tells her / she could win fame / and fortune / on the
 stage./ The two / are in close / conversation / when Browne /
 unexpectedly / arrives home./ To him / appearances / speak
 ill;/ he orders / Manteaux / out of his house;/ Gertrude,/ at
 the same time,/ trying / to intercede for her visitor./ Fail-
 ing in this,/ she flies off / and denounces her husband./

mentioning the fact / that Manteaux / has what they lack-/
auto, diamonds,/ money!/

Browne tries / to forget the incident / and goes ahead /
with his work,/ One day / he receives a medal / from a
scientific / society,/ in recognition / of a new / chemical /
element / he has discovered;/ also a telegram congratulating
him / on the honor,/ adding,/ however,/ that the discovery /
/ is of no / commercial / value./ He rushes home / to tell
Gertrude / of his good success./ She / however has just re-
ceived / an offer / from Manteaux,/ now back in New York,/
of a leading / role / in a new / opera / he is producing,/
provided she can come / at once / and begin rehearsing./ When
her husband / shows her / his laurels,/ she coolly / informs
him / she is not looking / for "honors" but money./ She de-
cides / to accept / the offer / and leaves her husband,/ child/
and home / for New York,/ where Manteaux / shows her / the
gay / life./

In the meantime,/ Browne / (his health threatened)/ has
put Robbie in school,/ gone west / and made good / as fore-
man / on the ranch / of a Mr. Sanderson./ There/he discovers,/
by dint / of his knowledge / of chemistry,/ rich / copper /
deposits / and later / is made / half / owner / of the ranch /
by his grateful / employer./

Gertrude / achieves a triumph / in opera,/ but success /
turns her head./ She inclines / a deaf ear / to her husband's /
entreaties / to return / and when / at a ball,/ nobility /

smiles,/ she throws / the cold shoulder / even / to Manteaux./ Feeling her / slipping / from his control / Manteaux / conspires / with a doctor / to destroy / her voice./ This he does / by secretly / inoculating her/with a poisonous,/ voice-affecting / toxin./ The next day,/ while on the stage,/ her voice fails./ From that time,/ she gradually becomes dependent on Manteaux,/ who further seeks to weaken her will / by teaching her the opium habit./ When, however, he finds she doesn't yield / completely / to his desires,/ he casts her aside,/ with her wrecked voice / and a craving for opium,/ to battle as best she may./

Brown,/ in the meantime,/ having received the false / information / that his wife is dead/has married/the rancher's daughter./

Gertrude sinks / lower and lower / in the clutches / of the opium-smoking/habit./ Realizing / her lost / condition,/ she decides / to return to her husband./ Pawning / her last diamond,/ she goes west only to find / her husband / married / and happy / with another woman./ She returns to New York / and there,/ in an opium den,/ dreams her life over again./

Logical Memory Test No. 3.

The World's Oldest Inhabitant .

"Several years ago,/ when / the son-in-law / of Karl Habenbeck,/ the animal/trainer,/ was looking for / interesting

specimens ,/ he learned / of the existence / on an island / off the coast / of Madagascar / of a giant / tortoise,/ that was celebrated / among the natives / not / merely for its great / size -/ it weighs / 9/7/0/ pounds-/ but / for the fact / that there was documentary / evidence / that it had been living / on the earth / for over / 1/5/0/ years / and probable / evidence / that it was from 1/0/0/ to 1/5/0/ years / older / than that,/ After careful / investigation,/ he was satisfied / of the truth / of the statement,/ and set about / to secure / the loan / of this animal / (which,/ by the way,/ is held / in the highest / esteem / and respect / on the island), for exhibition / at the St. Louis / World's / Fair. / Not until the strongest / assurances / were made / that the venerable / curiosity / would be returned / to the island / did the native / population / consent / to part / with him / for his long / vacation./ We are informed / by Mr. Habenbeck / that when / the tortoise / reached / this country,/ it was found / that a tiny / palm / tree / was growing / from the back / of the creature./ The tortoise / loves / the mud,/ and it is evident / that soil / was washed / into a deep / scar / on his back / and that the seeds / of the palm,/ mixed / with the earth,/ took root / and the tiny / growth / had thrived / in its portable / field./ The tortoise / is the longest lived / animal,/ exceeding / even / the elephant,/ which / frequently / exceeds / one / hundred / years / of life./ The fact / that about 1/5/0/ years ago / the natives / began / to take particular / pride / in this tortoise / because of / its age / makes

it certain / that it must have been / at least / one / hundred / years / of age / at that time/ This is borne out / by the condition / of the shell,/ which is a guide / concerning / its age./ Further / evidence / is its most abnormal / size./ It possesses / extraordinary / lifting / strength./ While it was in / its heavy / cage / at the World's / Fair / express / office,/ it became impatient / and proceeded / to break its way / out./ It smashed / the heavy / 2 / by 8 / timbers / with ease./ The accompanying / snapshot / shows / two / children / taking / a novel / ride / upon the back / of this giant / sea / monster."/

Logical Memory Test No. 4.

Mr. Folk's Victory in Missouri.

The nomination / of Joseph / W./ Folk,/ the young / circuit / attorney / of St. Louis,/ to be governor / of Missouri,/ is hailed / as a triumph / for honesty / in public / affairs / and an event / of national / importance./ "So signal / a victory,"/ declares / the New York / Sun / "has a range / and significance / that extend / far / beyond Missouri;/ everywhere / Democrats / will be encouraged / and independents / attracted / by this new / evidence / of the rejection / by the Democratic / party / of its baser / elements"/ When / Mr. Folk / started / his campaign / for the Democratic / nomination / for governor,/ the Democratic / State / "machine"/ set / to crush him./ By a direct / appeal / to the people / against / political / corruption,/ he gained / the public / sympathy,/ and fully / two / months / previous / to the

State / convention / his leading / opponents / acknowledged /
their defeat./ He was nominated / by a vote / of 5/4/9/ to
1/6/0./ and his election / is regarded / as a foregone / con-
clusion./

Method of Grading.- The subject's written reproductions
of the selections were compared, unit by unit, with the se-
lections as divided above. One credit was allowed for each
idea or unit adequately reproduced.

2. Rote Memory.

Object.- The object of this test is to determine the immediate memory of the pupil for unrelated material. It tests merely verbal memory, memory for discrete impressions

Method.- Four tests of this kind were given; two were lists of concrete words, and two were lists composed of abstract words. In each case the first group of words (there were three words in this group) was pronounced and the subject was then given time to write the words. Following this, the second group of words was read and so on, until all six groups had been pronounced. Blanks were furnished to subjects in the following form:

First list. Concrete.

1.
2.
3.

1.
2.
3.
4.

1.
2.
3.
4.
5.

etc.

First list. Abstract.

1.
2.
3.

1.
2.
3.
4.

1.
2.
3.
4.
5.

etc.

The instructions to all the subjects were the same; "I shall pronounce in your hearing a number of words, one group of words at a time. There are three words in the first group, four in the second, five in the third, six in the fourth, seven in the fifth, and eight in the sixth. As soon as I have pronounced a group of words, you are to write them down. Try to write them in the same order ^{in which} ~~that~~ they are given.

If you cannot remember some of the words, leave their places vacant and write in the proper places the words you do remember." The following material was used:

Rote Memory Material.

First List. Concrete.

1. spade
2. fox
3. sand

1. road
2. moon
3. knife
4. town

1. light
2. milk
3. room
4. time
5. gold

1. rock
2. mind
3. pass
4. moat
5. reef
6. fire

1. leaf
2. coal
3. home
4. chin
5. shot
6. fare
7. calf

1. walk
2. song
3. crow
4. street
5. fold
6. boat
7. wire
8. stand

Second List. Concrete.

1. ring
2. slate
3. grass

1. dog
2. book
3. wheel
4. man

1. house
2. cow
3. hand
4. pond
5. bell

1. rain
2. jail
3. car
4. fog
5. cat
6. screw

1. ship
2. card
3. iron
4. rice
5. horse
6. wind
7. chair

1. pen
2. boy
3. well
4. smoke
5. yard
6. hall
7. stick
8. bird

First List. Abstract.

Second List. Abstract.

1. knock
2. truth
3. howl

1. void
2. death
3. noise
4. jerk

1. cure
2. phase
3. hurt
4. scope
5. din

1. month
2. scorn
3. peace.
4. kin
5. art
6. harm

1. power
2. health
3. lie
4. song
5. sob
6. height
7. shade

1. pose
2. clash
3. joke
4. means
5. trot
6. jaunt
7. taste
8. year

1. sweet
2. swift
3. old

1. warm
2. mad
3. smooth
4. bright

1. small
2. bad
3. gray
4. loose
5. dull

1. green
2. low
3. soft
4. queer
5. firm
6. cross

1. large
2. clear
3. light
4. ripe
5. long
6. big
7. square

1. round
2. high
3. young
4. rough
5. short
6. fair
7. clean
8. odd

Method of Grading. - The work was graded, not only on the basis of memory, for the words, but for their positions. A word remembered counted one point, and its correct position one point. The word in its correct position, therefore, counted for two points. If the three words of the first group were remembered and put in their proper order, they counted for six points. A perfect score would be 66 points for each list.

Tables of Objects.

Object. - The purpose of this test was to determine the immediate memory of the subject for objects.

Method. - A large cardboard was prepared, and on it at odd places were written the digits from 1 to 10. This cardboard was then laid on a table and an object was put on each place where a digit has been written. The subject was then brought before the table, which was screened from his view by another large cardboard. The next move was to give the subject an idea of how long a period six seconds is. This was done by means of a seconds' pendulum. After a signal "ready now" the screen was removed and the subject allowed to examine the object on the table for a period of six seconds, at the close of which time the screen was replaced. The subject then reported as many of the objects as he could remember, the record being kept by the experimenter. The instructions used were: "I have placed on the table before you ten objects. I shall give two signals; the first one, which is the word 'ready' will be followed a second later by the word 'now', at which time the screen will be removed. You are to examine the objects on the table with the view of remembering just as many as possible. The objects are familiar to you. The exposure time is six seconds. At the close of this period, the screen will be replaced. You are then to report to me as many of the objects as you can remember.

Six tests of this description were used. The material is given on the following page.

Materials Used in Tables of Objects Test.

1st Test.

1. key
2. book
3. pencil
4. hammer
5. watch
6. scissors
7. envelope
8. paper box
9. handkerchief
10. spectacles

2nd Test.

1. spoon
2. stone
3. orange
4. can
5. penholder
6. kewpie doll
7. mirror
8. soap
9. bottle
10. thread

3rd Test.

1. glass
2. kodac
3. toothbrush
4. shoe
5. brush, clothes
6. cookie
7. potato
8. basket
9. cup
10. nail

4th Test.

1. block
2. saucer
3. bunch of string
4. piece of chalk
5. bunch of paper
6. knife
7. ruler
8. brick
9. screw driver
10. quarter

5th Test.

1. ten box
2. comb
3. ink bottle
4. vase
5. 2 leaves
6. chain
7. bucket
8. glove
9. card
10. nut

6th Test.

1. hair pin
2. pan
3. eggshell
4. light bulb
5. button hook
6. matches
7. bread
8. eraser
9. shoe horn
10. carbon paper

Free Association.

Object.- The purpose of the association test is to determine the quickness of the association processes.

Method.- In the uncontrolled or free association tests the subject was given an initial word by the experimenter. He was then instructed to say as fast as possible as many other words as came into his mind. No restriction was put upon his flow of ideas. He said whatever he thought of. The time allowed in each of these test was three minutes. The result of the test is a criterion of the rapidity of flow of one's ideas when no limitation is put upon this flow. The instructions were as follows: " I am going to start you with one word. As soon as I have given you this word, you are to speak just as rapidly as possible for a period of three minutes, other words that come into your mind. You are not to use sentences or connected thought, however, By connected I mean such things as counting, giving the alphabet, etc. My object is to see how rapidly ideas flow through your mind. Speak as rapidly as possible. "

Four test of this kind were given. The initial words were "sky", "Chicago", "Kipling" and "election".

Method of Grading.- The tests were graded by merely counting the number of words spoken. Of course this performance has a qualitative aspect, but only the quantitative aspects are ^{considered} ~~treated~~ here.

Controlled Association.

Object.- The purpose of this test is similar to that of the test just preceding - to determine the quickness of the association processes. The difference lies in the fact that in the controlled association tests a limitation is put upon the flow of ideas.

Method.- In this test the subject is not to write just any words that come into his mind, but only words that satisfy certain conditions. In the tests used in this experiment the subject was to give the opposites of certain words. The associations tests are of great significance in diagnosing mind for they test function that are at the very basis of the reasoning process. When a person is given a problem in life to solve, it is nothing more than a test in controlled association. The problem starts the flow of ideas and limits this flow by its own condition. The method of procedure used here was to give the subject a printed list of fifty words to each of which he must write an opposite. The instructions were: "You have on these slips of paper fifty words. You are to write after each word its opposite. For example, if one word were "far", you could write as its opposite "near". You are to write them just as rapidly as possible. Let me suggest if you come across a word whose opposite meaning does not readily occur to you that you skip the word temporarily and then come back to it and fill in the meaning *later*."

Method of Grading:- Three tests of this kind were given. These were graded by keeping the time by means of a stop-watch.

OPPOSITES--List No. 1.

1. strong	26. hot
2. deep	27. long
3. lazy	28. wet
4. seldom	29. fierce
5. thin	30. great
6. soft	31. dead
7. many	32. cloudy
8. valuable	33. hard
9. gloomy	34. bright
10. rude	35. fine
11. dark	36. plain
12. rough	37. sharp
13. pretty	38. late
14. high	39. sour
15. foolish	40. wide
16. present	41. drunk
17. glad	42. tight
18. strange	43. empty
19. wrong	44. sick
20. quickly	45. friend
21. black	46. above
22. good	47. loud
23. fast	48. war
24. clean	49. in
25. tall	50. yes

OPPOSITES--List No. 2.

1. delicate	26. strength
2. thick	27. humble
3. expensive	28. smallest
4. freeze	29. idle
5. kind	30. many
6. death	31. increase
7. man	32. neat
8. bashful	33. lend
9. true	34. prudent
10. ugly	35. before
11. reap	36. over
12. sweet	37. up
13. come	38. swift
14. tough	39. here
15. future	40. winter
16. honest	41. can't
17. gay	42. wont
18. easy	43. brave
19. high	44. believe
20. near	45. forget
21. rich	46. old
22. laugh	47. like
23. love	48. little
24. ripe	49. failure
25. poverty	50. far

OPPOSITES--List No. 3.

1. night	26. conceal
2. definite	27. plaintiff
3. near	28. hope
4. absent	29. just
5. buy	30. useful
6. forward	31. inhalation
7. back	32. wise
8. equal	33. insane
9. ascend	34. fertile
10. wild	35. first
11. positive	36. top
12. yea	37. unknown
13. off	38. faithful
14. synonym	39. expand
15. clear	40. graceful
16. advance	41. soluble
17. obedient	42. going
18. live	43. rigid
19. open	44. abundance
20. locked	45. include
21. quick	46. concave
22. interesting	47. dwarf
23. north	48. regular
24. east	49. happy .
25. inlet	50. add

Learning Nonsense Syllables.

Object.- The purpose of this test is to determine how rapidly the individual can learn material which is entirely meaningless

Method.- This test involves, in a way, the breaking up of old habits of learning, since the material to be learned is of an entirely different nature from that usually put before us to be learned. In this test we made use of Jastrow's Memory Apparatus. A full description of this apparatus is given in Whipple's "Manual of Mental and Physical Tests". By the use of this apparatus a series of ten nonsense syllables was exposed at the rate of one syllable per second. The syllables were composed of three letters, two consonants and a vowel - the order being consonant, vowel, consonant. Time was kept by means of a seconds pendulum. The instructions were as follows: "I am going to expose a series of ten nonsense syllables at the rate of one syllable per second. These syllables will appear in the small opening which you see in the apparatus here. After all ten syllables have been exposed you are to write down in their order as many of the syllables as you can remember. Write them on the outer edge of your paper in vertical lines. After you have written all that you can remember of the first series, turn your written work under and I shall expose the series again. I shall continue the exposures until you have learned all ten syllables in their proper order."

Five tests of this kind were given. I give these on the following page.

Material Used in Learning Test.

(Nonsense Syllables)

1st.Test.	2nd.Test.	3rd.Test.
1. wem	1. wep	1. rax
2. buv	2. tox	2. vun
3. luz	3. bol	3. zav
4. zof	4. dud	4. lut
5. fax	5. dij	5. joz
6. kuz	6. dac	6. ful
7. wup	7. mel	7. cas
8. zuk	8. tup	8. vup
9. naf	9. deg	9. toh
10.dag	10.jat	10.lac

4th.Test.	5th. Test.
1. hom	1. dut
2. jub	2. rif
3. rav	3. tah
4. vet	4. vud
5. wox	5. fek
6. gop	6. jad
7. dez	7. fum
8. jus	8. mox
9. lof	9. hed
10.vez	10.nid

Method of Grading.- The work in these tests was graded by simply counting the number of exposures required to learn the ten syllables in their proper order.

7. Learning Letters for Digits. "Substitution Test"

Object.- The purpose of this test was to determine each subject's learning curve.

Method.- Five tests of five minutes duration each were given, - one on each day for five successive days. The subjects were given blanks of the kind shown on the following page and told to substitute letter for the digits as rapidly as possible. The instructions were: "On the other side of this paper you will find a column of digits. There are five digits in each row. There are twenty rows in each column. Opposite each row of digits are five blank squares. At the top of the page you will find a key consisting of nine letters, one letter for each of the nine digits. You are to substitute in the five blank squares the letters corresponding to the digits immediately preceding them. You are to work until you have filled all the blank squares with the letters. Work as fast as you can." These instructions were illustrated and made clearer by exhibiting one of the blanks without the key to show them just what they might expect.

Method of Grading.- The method of grading was to keep by means of a stop watch the time of each performance. From these figures I have plotted the learning curves of the different subjects. I have also calculated the per cent. of increase in efficiency between the initial practice and the final efficiency. A blank exhibiting this test is shown on the following page.

1.
n2.
b3.
d4.
t5.
r6.
y7.
c8.
s9.
h

84,976						27,516					
79,821						33,821					
63,442						97,473					
21,629						62,978					
57,183						31,542					
32,761						17,143					
95,146						26,981					
28,349						35,724					
73,862						16,315					
91,563						14,923					
37,628						34,762					
42,916						28,543					
23,729						83,936					
85,652						75,314					
35,486						56,283					
29,635						19,175					
72,518						36,293					
24,631						85,746					
19,852						15,283					
76,431						24,976					

Name

Date

Sex

Age

Grade

8. Learning Symbols for Letters.

Object. - The purpose of this test was to determine the learning curve of each subject. Of course this object includes several other important factors such as the amount learned in the initial practice, the absolute amount learned, percent of increase of final efficiency over initial efficiency etc.

Method. - In this test each subject was given a key which contained twenty six symbols, one for each letter of the alphabet. In the initial practice they were given a definite amount of prose material to copy. The grade was based on the time it took the subject to copy the entire selection in the new symbols. In the other four practices the procedure was the same. Five practices were given in all, one on each day for five successive days. The directions were: "On this sheet of paper I have written the twenty six letters of the alphabet. Under each letter I have placed a symbol. I have also marked off a certain section in this book (the book was then laid before them and the exact paragraph indicated). You are to copy this section in the new symbol. Make the symbols plain enough to be read, but work as fast as ever you can."

Method of grading. - The method used in grading was to keep the time for each performance by means of a stop watch. In my final tables I have used as the mark for this test the absolute amount learned in all five practices. However, the other factors, such as the learning curve, amount learned in

the initial practice etc. I have shown in separate tables and graphs.

The key used in this test is given below:

a	b	c	d	e

f	g	h	i	j

k	l	m	n	o

p	q	r	s	t

u	v	w	x	y

z

9. Learning Poetry by the Tachistoscope.

Object. - The purpose of this test was to see how rapidly the subjects could learn meaningful material, when the time allowed them to learn this material was limited.

Method. - A poem with ten stanzas was typewritten, and each stanza was then pasted on a cardboard which fit the clamps on the tachistoscope. The subject was seated so that his head was supported in the head rest without undue strain. The tachistoscope was set for an exposure of three seconds duration. As a preliminary exercise a very simple exposure cards were exposed in the holder in order to give the subject some idea of what was expected of him as well as to show him the amount of time he would be allowed to view each stanza. (For a detailed description of the disc tachistoscope see Whipple's "Manual of Mental and Physical Tests"). All through this experiment the subject was given two signals before each exposure. Whenever the subject thought that his attention was thoroughly prepared, he gave the signal "ready"; this was followed by the two signals from the experimenter - "ready" and "now". At the second signal the disc was released and the stanza exposed. The exposures were continued until the entire stanza was learned. After each exposure, the subject reported verbally all that he had learned of the stanza. The instructions were: "I am going to expose by means of the tachistoscope a stanza of poetry. The stanza contains four lines. Each line has four feet, each foot two syllables. The first line rhymes with the third, and the second with

the fourth. Immediately after each exposure you are to tell me all that you remember of the stanza. Let your object be to see all you can at each exposure and remember all you see. Try to completely learn the stanza in as few exposures as possible". Of course a complete explanation of the tachistoscope and its workings was given in connection with the instructions.

Method of grading. - The mark for this test was simply the number of exposures required to learn the stanza.

Note - This test was extended over four days. Stanza number one was given the first day and three stanzas were given on each of the three succeeding days. The material used in this test is given on the following page.

Material Used in Learning by Tachistoscope.

(Poetry)

1. The world's a very happy place.
Where every child may dance and sing,
And always have a smiling face,
And never sulk for anything.
2. I waken when the mornings come,
And feel the air and light alive
With strange sweet music like the hum
Of bees about their busy hive.
3. The linnets play among the leaves
At hide-and-seek, and chirp and sing;
While, flashing to and from the eaves,
The swallows twetter on the wing.
4. And twigs that shake, and boughs that sway,
And tall old trees you cannot climb,
And winds that come, but cannot stay,
Are singing gayly all the time.
5. From dawn to dark the old millwheel
Makes music, going round and round;
And, dusty white with flour and meal,
The miller whistles to its sound.
6. The brook that flows beside the mill,
As happy as a brook can be,
Goes singing its old song until
It learns the singing of the sea.
7. For every wave upon the sands
Sings songs you never tire to hear,
Of laden ships from sunny lands
Where it is summer all the year.
8. And if you listen to the rain
Where leaves and birds and bees are dumb,
You hear it pattering on the pane
Like Andrew beating on his drum.
9. The coals beneath the kettle croon,
And clap their hands and dance in glee;
And even the kettle hums a tune
To tell you when it's time for tea.
10. The world is such a happy place
That children whether big or small,
May always have a smiling face
And never, never sulk at all.

10. Range of Visual Apprehension.

(letters)

Object. - The tests of visual apprehension are commonly assumed to measure such capacities as "power of observation", "quickness of perception", "range of attention," "mental grasp," etc. "They are practically confined to the sphere of visual perception, and imply that this perception takes place under active attention; thus, in general, they seek to determine the subject's capacity to perceive visual symbols when the conditions of perception are limited by short temporal persistence of the stimulus, or by other difficulties or complications that are intentionally introduced." Of course other factors besides the mere perceiving enters into this and following tests. I have introduced in these tests other elements such as memory, powers of description, etc.

Method. - Gummed letters were placed on cardboards in series of four, five, six, and seven. At the beginning of the experiment shorter series were exposed, consisting of one, two and three letters. This was done in order to acquaint the subject with the general procedure. The exposure time was very short; in fact, just ^{time for} a passing glance. The instructions were: "I am going to expose a series of letters. This series consists of _____ letters. Only one exposure of each group of the letters will be given. After each exposure you are to write them down in their order if possible. I shall, before every exposure give two signals, "ready" and "now". My two signals will be

given after you have written down the letters of the preceding exposure and have let me know/that your attention is fixed on the fixation card by the word "ready". Of course these instructions were accompanied by explanations and illustrations on the tachistoscope. This test was all given at one sitting.

Method of grading. - The method of grading in this test was to assign one unit for each letter correctly reproduced, but to deduct 0.5 for errors of insertion or transposition. This means that a letter in the right place counted one unit, but a letter not in its proper place counted 0.5. The material used in this test is given on the following page.

Material Used in Range of Visual Apprehension Test.

(letters)

Series consisting
of four letters

1. RNGF
2. GBFJ
3. LJPC
4. DJOC
5. TRPJ
6. NDTR
7. PXSR
8. SJFH
9. LFKB
10. BOXC

Series consisting
of five letters

1. NMCLH
2. KRHBJ
3. CSMTB
4. OGXFP
5. WDNVL
6. LWHCN
7. YWNTC
8. KPJWG
9. ZRJYH
10. DSBTM

Series consisting
of six letters

1. RDZMHT
2. GNLXDP
3. MDWBLS
4. JPSEFWT
5. NYJDKF
6. BSJQMD
7. CKSNVW
8. KPMCNB
9. HTMGXL
10. KNDJYF

Series consisting
of seven letters

1. BWDMSLC
2. KVSNWCH
3. DNPGXRL
4. JVNFKDP
5. SBJQDMF
6. MKBQNGT
7. BMLRZJS
8. LZJBMRV
9. SFPWJTK
10. CHZMTRJ

11. Range of Visual Apprehension.

(Pictures)

Object. - The general purpose of this test is included in that of the preceding test. The specific purpose was to test the range of the subject's observation and his memory for the things observed. It is also intended to test the subject's power of grasping a situation when the things he has to judge by, are placed before him for only a very limited time.

Method. - Ten pictures were chosen as representative of ten different situations. These were exposed to the subject's view for a period of three seconds each. This was done by means of the tachistoscope. The instructions were: "I am going to expose a series of ten pictures. Each exposure will be for a period of three seconds. You are to examine the pictures very closely and report to me at the end of each exposure everything that you have seen. Report everything in detail. Include color, size, number, - in fact, report everything you can remember, both qualitative and quantitative". This test was given at one sitting.

Method of grading.- In grading this test, the experimenter had in mind ten main points in each picture. The grading was based on the experimenter's judgment of how well the subject took up both the qualitative and quantitative aspects of each of these ten points. Each subject's report was followed by a series of questions asked by the experimenter.

12. Range of Visual Apprehension.

(Poetry)

Object.- The general purpose of this test has already been stated. The specific aim is to determine the amount of logical material the subject can grasp in a certain limited time.

Method.- A series of ten stanzas of poetry was exposed by means of the tachistoscope. Each stanza contained four lines. The method used was to expose each stanza once and after each exposure require the subject to report what he remembered of the material seen. As in the preceding tests two signals were given, "ready" and "now". The directions were: "I am going to expose ten stanzas of poetry, one stanza at a time. Each stanza contains four lines. You are allowed three seconds to see each stanza. After each exposure you are to report to me all the words that you remember to have seen in the stanza. I do not care what method you employ in getting the words - whether you give them in logical order or scattered here and there. Remember your object is to see all the words you can and remember all you see."

Method of Grading.- This test was marked according to the number of words reported by the subject. The material used in this test is given on the following page.

Material Used in Range of Visual Apprehension (Poetry).

Gone.

1. Another hand is beckoning us,
 Another call is given;
And glows once more with angel steps
 The path which reaches heaven.
2. Our young and gentle friend whose smile
 Made brighter summer hours,
Amid the frosts of autumn time
 Has left us with the flowers.
3. The light of her young life went down,
 As sinks behind the hill
The glory of a setting star,-
 Clear, suddenly and still.
4. As pure and sweet, her fair brow seemed
 Eternal as the sky;
And like the brook's low song, her voice,-
 A sound which could not die.
5. And half we deemed she needed not
 The changing of her sphere,
To give to Heaven a Shining One,
 Who walked an angel here.
6. The blessing of her quiet life
 Fell on us like the dew;
And good thoughts, where her footsteps pressed,
 Like fairy blossoms grew.
7. Sweet promptings unto kindest deeds
 Were in her very look;
We read her face as one who reads
 A true and holy book.
8. We miss her in the place of prayer,
 And by the hearth fire's light;
We pause beside her door to hear
 Once more her sweet "Good night".
9. There seems a shadow on the day,
 Her smile no longer cheers;
A dimness on the stars of night,
 Like eyes that look through tears.
10. Alone unto our Father's will
 One thought hath reconciled;
That he whose love exceedeth ours
 Hath taken home his child..

13. Spot Pattern Test .

Object.- The purpose of this test is the same as the one stated in the four preceding tests. In this case the things for which we wish to determine the subjects' range are different arrangements of spots on the inter-sections of vertical and horizontal lines.

Method.- In this test different arrangements of spots were exposed. Five series were given. Each series contained five different arrangements of spots. In the first series each arrangement contained seven spots; in the second series each arrangement contained eight spots; in both the third and fourth series each arrangement contained nine spots; in the fifth series each arrangement contained ten spots. These arrangements of spots were prepared before hand and placed on card-boards. Of course each arrangement differed from every other arrangement. I give two sample arrangements below:

It was necessary for each subject to be supplied with small recording sheets. A great number of these were prepared in the following form:

Top.

The method of administering the tests ^{was} ~~were~~ as follows: An arrangement of spots was placed in the holder of the tachistoscope. The signals "ready"- "now" were then used. The disk was released on the second signal. The exposure time was two seconds. After each exposure the subject placed on a recording sheet the arrangement of spots, as he remembered them. This sheet was then passed to the experimenter who passed on it as "right" or "wrong". The exposures were continued until the subject had arranged the spots in the proper way.

After the first series of spots had been exposed, each subject was asked what method he used in remembering the arrangements. The following answers were given:

Mr. A. reported that he saw the spots in clusters. He would write down one cluster of spots and then write

the other cluster by refering it to the first cluster.

Mr. B reported that his best way of retaining was in counting how many lines had spots on them. Sometimes he counted vertical lines, sometimes horizontal.

Miss C reported that she first located a spot in the upper left hand corner; then noticed the distance the spot was from the edge; then the distance down from the top; whe then refered this spot to its group. She then refered this group to another group; then vaguely to still another group. This introspection was given after the first exposure.

Mr. D. reported that he followed the horizontal lines, noticing the different spaces between the spots.

Miss E reported that she first fixated the spots on the first horizontal line and then placed the others in reference to these.

Miss F reported that she saw all the spots as a pattern. She put down all the spots every time.

Miss G reported that she did not use the same method every time. She usually started at the top and followed the first horizontal line. She then fixed the dots that were under the dots in the horizontal line.

Miss H reported that she followed the horizontal lines, counting and locating the dots on each line.

Miss I reported that she first saw the upper horizontal line, then looked down and fixated on a group and finally located others in reference to this group.

The instructions in this test were: "I ^{shall} ~~am going to~~ expose in the tachistoscope a cluster of spots arranged on a series of horizontal and vertical lines. The spots will be placed on the intersections of these lines. The lines will be arranged in the same manner as are those on the little recording sheets which you have on the table before you. No spots will be placed on the outside border line. The arrangement of spots will be exposed for a period of two seconds. You are to notice the arrangement closely and endeavor to reproduce it on the record sheets. If you do not succeed after the first exposure, I shall continue the exposures until the arrangement is correctly reproduced. At the end of each exposure you are to hand the record sheet with the spots you have placed upon it to me. I shall judge it "right" or "wrong". No other information will be given. As in the other experiments with the tachistoscope. There will be two signals, "ready" and "now". Try to get the arrangement of spots in just as few exposures as possible."

Method of grading. - The marks for this test consisted in counting the number of exposures required to correctly reproduce a pattern.

14. Test of Mechanical Ability.

Object.- The purpose of this test was to determine the ability of the subject to work with unknown material in the form of a toy bank and a puzzle box and solve their 'mysteries'. For want of a better name I have termed this combination of tests as a "Test of Mechanical Ability".

Material.- The apparatus used in this test was a puzzle box and a bank. The puzzle box consisted of wood, glass, steel pegs, and metal rings connected with springs. The box was almost square in shape. Five of the sides were made of wood. The ~~sixth~~ side was a glass door. Arranged in various places on the inside were steel pegs. Over these pegs were glass rings connected by a net-work of strings. This net-work was fastened to a metal hook which ran through a staple which held the glass door shut. In order to open the door it was necessary to move certain rings first in order to release certain other rings and finally to release the metal hook which held the door shut. On three of the sides of the box were small holes through which the subject could push a shoe hook and remove the rings. The directions were as follows: "You have before you a puzzle box. You are to open the box as soon as you can. Before you open it, however, notice the arrangement of rings and strings well enough to be able to close the box and arrange the rings in the same order as you now find them. The only instrument you need

is this shoe hook."

The bank was in the form of a combination lock box. It was to be opened by means of working a combination and moving three levers and a brass button. The directions to the subject were: "I want you to open this bank just as soon as possible. Listen closely while I give you the instructions. Turn the combination lock slowly to the right to 50, turn the lock slowly back to the left to 49, then turn the lock back to the right until it clicks; pull out the lever on the left, pull up the lever on top, push the brass knob to the right, turn the lock and open the door." This test is of course a combination ^{ability to understand and remember a} of complicated command and mechanical ability. If an order was forgotten, the experimenter furnished the information necessary to proceed with the test. That part of the test consisting of the complicated command was not taken account of in the results, my interest being in the mechanical features involved.

Method of grading. - The marks for these tests consisted of the time required to do the tasks assigned. In the final tables all three tests are pooled under one head and are designated as "Mechanical Ability". I give a rough sketch of the puzzle box and bank on the following page.

65.

15. Fast Forward Reading Test.

Object. - The purpose of this test was to determine how rapidly the subject accomplished such ordinary tasks as reading.

Method. - The method used in this test was to place before the subject a selection to be read. The instructions were: "On the other side of this piece of paper is a printed selection. You are to read this selection as rapidly as possible. The selection is composed of good English. Do not read so fast that you mumble your words. However, all that is necessary in the way of enunciation is to read so that what you are saying would be intelligible to a person near you."

Method of grading. - The mark for this test consisted in simply recording the time required to read the selection as indicated by a stop watch. The material used in this test is given on the following page.

Name Date

READ ALOUD AS FAST AS POSSIBLE WITHOUT MAKING MISTAKES

Many of the Indians lived in villages. These were nearly always small, seldom having more than a few hundred people in them, and as a rule even less. In many tribes these villages consisted of wigwams, which were occupied by single families. To construct a wigwam a few poles were planted in a circle, and the ends gathered together and fastened at the top, where a hole was left for the smoke to escape.

The wigwam, both within and without, was covered by skins, mats, or bark. Sometimes a bearskin served for a door. There was no floor except the bare earth, and no carpet. There were no chairs and there were no tables, but around the sides of the wigwam the Indians sometimes put brush or skins of animals, to sit or lie upon. There was also a platform or shelf for provisions and for the household utensils.

The Indians were hospitable to strangers, and whenever one found his way to a wigwam they were ready to give him both food and shelter. Suppose we pay an imaginary visit to one of the wigwams. Let us push aside the bearskin that serves as a door and enter. Altho it may be a cold day, there is no stove nor fire-place, for this frail structure has no chimney. But in the center of the room we find a fire in a hole or pit, where the squaw is cooking something to eat. The wigwam is somewhat smoky, but much of the smoke is going out thru the opening at the top. After a short time we may get used to the thick atmosphere and not mind it any more than the Indians do.

16. Complicated Prose No. I.

(Reading words backward)

Object. - The purpose of this test is to determine how much the subject's old habits interfere with his forming new habits.

Method. - The method used in this test was to place the material before the subject with the following instructions: "On the other side of the paper which is before you is some printed material which we call complicated prose. You are to begin at the bottom of the page and read backwards as fast as ever you can. The material is arranged in this fashion: suppose you wanted to write in complicated prose the statement 'The cat is black'. It would be as follows: blackiscatthe. You see there is no spacing or punctuation. Remember the object is to read it as fast as possible without making any mistakes. If you make a mistake, I shall stop you by saying 'no'".

Method of grading. - The mark for this test consisted in the time required to read the selection correctly. The material used is given on the following page.

Name Date

BEGIN AT THE RIGHT-HAND END OF THE LAST LINE
AND READ ALOUD AS FAST AS POSSIBLE
WITHOUT MAKING MISTAKES

piece
one of made sometimes were moccasins and leggings the moccasins and
leggings apron and sleeve short with garment upper loose awore squaw
called woman Indian the animal others some or deer a of sinew the thread
their and fish a of bone small was needle their use we as such thread and
needle had Indian the thought together sewed were moccasin the of
piece the foot hunters a for covering of kind best they made and noiseless
and soft were they thus soles no having in was that and respect one in
alike all were they detail of variety the whatever but ankle the from down
hung which flap had also some embroidered much in step the over piece
a had pattern selaborate more foot the over one and heel the behind seam
one had moccasin of kind simplest the them shaping of ways different had
tribes various the moccasins wore they do as leather of shoes wearing
of instead beads and claws bear teeth elk so of made necklaces wear
to like and ornaments of fond were Indian the finery other and beads
feathers bird quills porcupine with embroidered were these sometimes
skin of robe had they occasions festive for buck skin of leggings wore also
ment the behind and front in down hanging beads with decorated ends
the waist the around belt a by place in held was this long feet of number
a and wide more or foot a skin of strip a wore ment the animals wild of skins
the of largely made was Indian the of dress the came men white the before

19. Complicated Prose No. II.

(Reading Letters Backward)

Object.- The purpose of this test is the same as that stated for the preceding test, viz., to determine to what extent the subject's old habits interfere with his actions in forming new habits.

Method.- The method used in this test was to place the material before the subject with the following instructions: "On the other side of the paper which is before you is some printed material, which we call complicated prose. You are to begin at the bottom of the page and read backward. The material is arranged somewhat differently from that of the test which you took yesterday. According to this scheme if you wanted to write the statement 'the cat is black' it would be as follows: koalbsitaceht. You see there is no spacing and ^{the order of the letters is reversed.} ~~no-pronunciation~~. The object of the test is to read the material as fast as possible without making any mistakes. If you make a mistake, I shall stop you by saying 'no'".

Method of Grading.- The mark for this test was simply the time required to read the selection correctly. The material used is given on the following page.

Material Used in Complicated Prose Test Number Two.

egdelwonkdnaeracelttilafotnawrofdednilbrodelppircefilhguor-
htgniogsitignihtlufdaerdatahwdnaecalpreporprihtfotuoerayeht-
nehwerasgnihtlufesuylgndeecxeesehtsuoregnadwohezilaerot-
noitalupopelohwehtetacudeottpecxeenodebnacgnihtondeednise-
itirohtuaehtybenodsignihtonhtnomanettuobaylnofotartane-
ppahdnayrtnocehtrevolladaerpserastnediccaehthesuacebtub-
dlrowehtrevollapuenogevahdluowlwohatahwemitenotadeneppah-
dahsihtfispacnitsalbhitiwgniyaipmorfsraeyeviftsalehtnief-
ilrofdelppirspahreprotruhneebevahnerdlihcederdnuhxisrevoe-
filafoneveroeyenarodnahafossolehtsitluserehtdnacnitsal-
bafogdirtracetimanydaebotsevorpenoelttilgnitcepsusnue-
htybdnuofgnihtyalpgnitaniacsftubddoehtsrepapehtnitneuger-
footgnittegerasevisolpxehgihtiwgniyaipfotluserasademi-
amrodelliknerdlihcfostnuocca

18. Scholastic Records.

Object.- The purpose of securing the scholastic records was to determine how the various teachers had ranked the subjects in their ordinary school work. Probably the chief aim was to be able to compare the marks secured in school by the subjects with the marks scored in the actual test, as shown in this experiment.

Method.- The method used to secure these scholastic records was as follows: In the University of Missouri students are graded on a comparative scale. The upper fourth of each class is given 15% extra credit (the highest ⁴ 4% is given 30% extra credit); the middle half of the class is given normal credit, 100%; the lowest fourth of the class is given 15% negative credit, this makes their grade 85% (the lowest ⁴ 4% are given no credit). On the books of the Registrar of the University, I found the number of hours each subject had taken and the per cent. of credit he had received. In order to make the table for these records comparable with the other tables using this experiment, I arbitrarily multiplied each positive and negative credit by $3 \frac{1}{3}$. By this method in reducing the figures to a scale where the average was 50, the range of latitude was in about the same proportion as that of the other tests. One can readily see that arbitrarily multiplying by the $3 \frac{1}{3}$, does not in any way effect the ranking of the subjects; neither does it influence the correlations materially.

For example, suppose I found on the registrar's books that a certain subject had received 109% credit for work done. I first multiplied 9 by $3 \frac{1}{3}$ which gives 30. I then considered his tentative grade as 130. The grades of the other subjects were treated in the same way. All the grades were then pooled and reduced to a scale of 50.

19. Imputed Intelligence.

The ranking of the subjects for this test was made in conformance with the directions as given by Stern in his "Psychological Methods of Testing Intelligence". The person making the estimations had had considerable psychological training. He had known all the subjects for at least a year and some of them longer. He was carefully instructed as to how he should perform his task. Although he knew in a general way the scholastic records of the subjects, he did not allow this to influence him any more than possible. Let me say in opposition to Stern's view, however, that in ^{estimating}~~imputing~~ the intelligence of an individual we can't throw away everything we know about him; we must judge him by his reactions in everything he does - in the class room, in the laboratory, in his conversations, in his dealings with his fellows, in a word, in solving all of life's problems. All these things were considered in ranking these subjects. I believe with Stern that this is one of the best if not the best method for judging an individual's intelligence. It is the test commonly applied in the world of business. It is practicable and workable. The only danger resulting from the method lies in the fact that we are liable to draw our conclusions from impressions too hastily gathered.

20. Tapping Test.

Object.- The purpose of this test is to secure the muscular reaction time of the subject. It is to see how quickly the response comes when a stimulus is applied.

Method.- The apparatus used for testing muscular speed is a tapping board consisting of metal plates having electrical connections with a kymograph, an electrical counter, a short-circuiting key and a seconds' pendulum. The instruments are so connected that when the subject strikes the tapping board with the metal stylus, the circuit is completed and the tap is recorded on the electrical counter and the kymograph. The subject was instructed to tap the metal plate as rapidly as possible. At the end of thirty seconds the connection was broken by means of a short-circuiting key and the number of taps they had made in thirty seconds was noted on the counter and kymograph and recorded by the experimenter. Five tests of this kind were given. The instructions were: "You are to hold this stylus in your hand in a vertical position. The object of the test is to tap this metal plate as rapidly as you can. I shall give you two signals, "ready" and "now". At the second signal you are to start and continue tapping until I stop you." Since all the subjects were right handed, this hand only was tested.

Method of Grading.- The mark recorded for this test was the number of taps made by the subject.

The Tables.

Probably a brief explanation of the tables which follow is necessary. I have numbered the tables from 1 to 20. All the tests of one kind being tabled under one number. For example, under Table 2 I have placed all the results of the rote memory tests; under Table 4 I have recorded the results of all the free association tests etc. The last table given under each number, 2c for example, contains the results of all the tests of that particular kind. These results have been pooled and reduced to a scale where the average mark is 50. The other tables under the number, as 2, 2a, and 2b, contain the original marks made by the subjects in each test. In these first tables the subjects are arranged according to rank. In the tables where the average is 50 the subjects are arranged in alphabetical order.

The graph on page 84 illustrates the progress of the subjects in the learning test where letters were substituted for digits. The curves start high and end low because the scale was drawn in terms of time. The lower the curve the greater the efficiency of the subject. The same sort of scale was used in making the graph on page 86.

Logical Memory (four tests)

Table No. 1.

Test No.	1	2	3	4	Average
Mr. A	92	156	133	66	111.75
Miss I	77	157	127	39	100.00
Miss H	78	150	133	38	99.75
Miss F	72	116	130	52	92.50
Miss C	86	116	99	47	87.00
Miss G	77	114	98	48	84.25
Mr. D	42	92	111	26	67.75
Miss E	45	92	76	28	60.25
Mr. B	53	90	50	39	58.00

Table No. 1a.

(final results of these tests reduced to a scale where the average is 50)

Mr. A	66
Mr. B	34
Miss C	51
Mr. D	40
Miss E	36
Miss F	55
Miss G	50
Miss H	59-
Miss I	59

Rote Memory

(two tests of concrete - two of abstract)

Table No. 2.
(concrete)

Test No.	1	2	Average
Miss F	58	62	60.0
Mr. D	57	60	58.5
Miss E	60	54	57.0
Miss I	60	53	56.5
Miss H	58	52	55.0
Miss C	48	53	50.5
Mr. A	51	49	50.0
Miss G	44	45	44.5
Mr. B	42	44	43.0

Table No. 2a.
(abstract)

Test No.	1	2	Average
Miss F	57	64	60.5
Mr. A	54	64	59.0
Miss H	52	62	57.0
Miss I	50	56	53.0
Miss C	50	52	51.0
Miss E	50	52	51.0
Mr. D	47	50	48.5
Miss G	41	46	43.5
Mr. B	41	43	42.0

Table No. 2b
(this shows average of
both tests)

Miss F	60.25
Miss H	56.00
Miss I	54.75
Mr. A	54.50
Miss E	54.00
Mr. D	53.50
Miss C	50.75
Miss G	44.00
Mr. B	42.50

Table No. 2c.
(final results of these tests
reduced to a scale where the aver-
age is 50)

Mr. A	52-
Mr. B	41
Miss C	49
Mr. D	51
Miss E	51 plus
Miss F	58
Miss G	42
Miss H	54
Miss I	52

Memory for Objects.

(6 tables of 10 objects each)

Table No. 3.

Table No.	1	2	3	4	5	6	total
Miss C	8	10	9	8	7	9	51
Mr. D	7	7	9	7	8	10	48
Miss I	8	8	9	6	8	9	48
Miss F	7	7	8	10	9	7	48
Mr. A	10	7	9	7	7	7	48
Miss E	7	7	8	8	9	8	47
Miss H	7	5	9	8	7	8	44
Miss G	8	6	8	8	5	7	42
Mr. B	7	5	6	7	6	9	40

Table No. 3a.

(final results of these tests reduced to a scale where the average is 50)

Mr. A	52
Mr. B	43
Miss C	55
Mr. D	52
Miss E	51
Miss F	52
Miss G	45
Miss H	48
Miss I	52

Free Association(4 tests)

Table No. 4

Initial word	"sky"	"Chicago"	"Kipling"	"election"	Avg.
Miss H	126	137	168	203	158.5
Miss F	111	112	200	184	151.8
Miss I	91	124	110	116	145.0
Mr. A	98	130	142	188	139.5
Miss G	56	64	88	85	73.3
Miss C	42	54	101	81	69.5
Mr. B	48	66	56	75	61.3
Mr. D	36	40	64	57	49.3
Miss E	39	58	48	49	48.5

Table No. 4a. (The average mark
in this table is 50)

Mr. A	70
Mr. B	31
Miss C	35
Mr. D	25
Miss E	24
Miss F	76
Miss G	37
Miss H	79
Miss I	73

Controlled Association - Opposites.
(3 tests of 50 words each)

Table No. 5.

Test No.	1	2	3	Average
Mr. A	2:01	2:18	1:47	2:02
Miss H	1:57	2:32	1:52	2:07
Miss G	2:22	2:38	2:45	2:35
Miss F	2:15	6:18	2:37	3:43
Miss C	3:06	5:19	3:11	3:52
Mr. D	3:26	4:40	3:48	3:58
Miss I	2:46	3:59	6:16	4:20
Mr. B	5:42	4:02	5:22	5:02
Miss E	9:33	4:46	11:26	8:35

Table No. 5a.

(final results of the tests reduced to
a scale where the average is 50)

Mr. A	83
Mr. B	33
Miss C	44
Mr. D	43
Miss E	20
Miss F	45
Miss G	65
Miss H	79
Miss I	38

Learning Nonsense Syllables.
(5 sets of 10 syllables each)

Table No. 6

Test No.						
Miss F	3	8	3	4	4	22
Mr. A	6	7	5	5	5	28
Miss I	10	4	8	4	5	31
Miss H	13	8	6	3	4	34
Miss C	14	9	6	6	7	42
Mr. D	14	8	6	8	6	42
Miss G	10	11	16	9	7	53
Mr. B	19	11	13	7	7	57
Miss E	17	12	14	9	11	63

Table No. 6a.

(final results of the tests reduced to a
scale where the average is 50)

Mr. A	67
Mr. B	32
Miss C	44
Mr. D	44
Miss E	29
Miss F	85
Miss G	35
Miss H	54 plus
Miss I	60

Substitution Test.

(letters for digits)

Table No. 7.

Test No.	1	2	3	4	5	Total
Miss I	4:24	3:05	2:26	2:13	2:04	14:12
Mr. A	4:16	2:57	2:47	2:38	2:32	15:10
Miss F	4:52	4:51	4:04	4:24	4:01	18:12
Miss H	5:20	4:34	3:44	3:35	3:10	20:23
Miss G	5:18	4:31	4:25	4:08	4:18	22:40
Mr. D	6:29	5:11	5:42	4:24	4:18	26:04
Miss E	6:15	5:40	5:06	4:58	4:36	26:35
Miss C	6:43	5:27	5:04	4:53	4:59	27:06
Mr. B	10:30	8:29	9:29	8:35	8:23	45:26

Table No. 7a.

%gain in the 5
practices.

Miss I	.530
Miss H	.406
Mr. A	.406
Mr. D	.336
Miss C	.272
Miss E	.264
Miss G	.220
Mr. B	.201
Miss F	.174

Table No. 7b.

(final results of the tests re-
duced to a scale where the
average is 50)

Miss I	76
Mr. A	71
Miss F	59
Miss H	53
Miss G	48
Mr. D	41
Miss E	40
Miss C	39
Mr. B	23

Note:- The figures on Table No. 7 are given in minutes and seconds. A low time represents a high efficiency. Table No. 7b is based on the total.

Practice no.

Graphs showing records made in substituting letters for digits.

Learning Test.

(symbols substituted for the letters of the alphabet)

Table No. 8

Test No.						
Miss F	26:58	20:15	13:27	11:49	15:38	88:07
Mr. A	30:30	21:16	14:21	12:17	15:10	93:43
Miss H	27:49	23:27	15:10	11:03	16:41	94:10
Miss G	28:28	23:29	16:49	13:37	17:01	99:24
Miss I	27:13	23:22	19:58	15:42	17:48	104:03
Miss E	36:10	28:12	19:28	17:10	22:25	123:25
Mr. D	38:26	29:43	20:01	18:42	22:10	129:02
Miss C	33:30	29:38	22:01	20:58	25:20	131:27
Mr B	64:38	61:58	38:57	28:56	36:11	230:40

Table No. 8a.

(final results of these tests reduced to a scale where the average is 50)

Mr. A	60
Mr. B	24
Miss C	43
Mr. D	44
Miss E	45
Miss F	64
Miss G	56
Miss H	60
Miss I	54

Practice no.

DEPARTMENT OF ENGINEERING, UNIVERSITY OF MO.

PLATE A - FOR SALE BY THE UNIVERSITY CO-OPERATIVE STORE, COLUMBIA, MO.

Graphs showing records made in substituting

Learning Poetry by the Tachistoscope Method.

Table No. 9.

Stanza No.	1	2	3	4	5	6	7	8	9	10	total No. of exposures
Miss I	4	4	5	4	2	3	2	2	4	2	32
Miss F	3	7	3	2	2	3	3	4	3	2	32
Mr. A	4	6	3	4	3	4	3	4	6	2	39
Miss H	5	5	4	4	4	5	3	5	5	4	44
Miss C	7	9	5	5	7	5	6	4	7	3	58
Miss E	6	11	8	8	4	6	6	4	4	2	59
Miss G	7	9	6	8	7	4	3	6	6	3	59
Mr. D	7	18	6	5	6	6	5	7	5	3	68
Mr. B	15	16	7	5	11	8	8	7	6	4	87

Table No. 9a.

(final results of these tests reduced
to a scale where the average is 50)

Mr. A	61
Mr. B	28
Miss C	42
Mr. D	35
Miss E	40
Miss F	75
Miss G	40
Miss H	54
Miss I	75

Range of Visual Apprension - Letters

Table No. 10.

No. of letters	4	5	6	7	Average.
Miss F	4.00	4.80	4.50	4.70	4.50
Miss H	3.65	4.00	4.25	3.95	3.96
Miss E	3.65	4.25	3.60	4.25	3.93
Mr. A	3.45	3.90	3.50	3.70	3.64
Miss I	3.80	3.60	3.35	3.75	3.62
Mr. D	3.80	3.10	3.45	3.40	3.44
Miss C	3.85	3.70	2.70	3.35	3.40
Miss G	3.10	3.10	3.20	3.05	3.11
Mr. B	2.40	2.50	3.25	3.25	2.85

Table No. 10a.

Mr. A	51
Mr. B	40
Miss C	47
Mr. D	48
Miss E	54
Miss F	62 plus
Miss G	43
Miss H	55
Miss I	50

(final results of these tables reduced to
a scale where the average is 50)

Range of Visual Apprehension - Pictures.

Table No. 11.

Picture No.	1	2	3	4	5	6	7	8	9	10	Average
Miss I	9.0	9.0	9.0	8.5	9.5	8.5	9.0	9.0	9.5	9.0	9.00
Miss F	8.0	8.5	9.5	8.0	9.0	8.0	9.5	8.5	8.5	8.5	8.60
Miss G	9.0	8.5	8.4	8.0	8.6	7.5	8.5	8.5	9.0	9.5	8.55
Miss C	8.5	8.5	9.0	8.5	8.0	8.0	8.0	8.0	7.5	9.0	8.30
Mr. A	7.5	7.5	7.0	6.5	7.0	6.0	6.5	8.0	8.5	7.0	8.15
Miss H	8.0	8.5	7.5	7.5	7.0	7.5	8.5	7.0	7.5	8.0	7.70
Mr. B	8.0	7.0	6.5	8.5	7.5	7.0	5.0	6.0	6.0	8.5	7.00
Miss E	6.0	5.0	4.5	5.0	5.0	4.5	6.0	4.5	5.5	5.0	5.10
Mr. D	7.5	6.0	6.0	5.4	5.0	4.4	3.7	3.2	3.0	4.8	4.90

Table No. 11a.

(final results of these tests reduced
to a scale where the average is 50)

Mr. A	54
Mr. B	47
Miss C	56
Mr. D	33
Miss E	34
Miss F	58
Miss G	57
Miss H	51
Miss I	60

Range of Visual Apprehension - Poetry.

Table No. 12.

Stanza No.	1	2	3	4	5	6	7	8	9	10	Total No. of words seen in ten exposures
Miss I	10	11	17	9	14	13	13	19	19	9	134
Miss F	11	12	17	10	14	16	15	14	15	9	133
Mr. A	11	10	19	6	15	16	10	15	13	9	124
Miss H	12	8	14	11	10	15	11	12	12	10	115
Miss C	10	4	13	10	10	13	9	12	11	9	101
Miss E	7	9	10	8	9	12	5	12	12	8	92
Miss G	8	7	9	6	8	12	8	11	9	8	86
Mr. D	5	6	8	8	7	8	4	9	6	7	68
Mr. B	5	8	10	7	5	6	7	7	10	2	67

Table No. 12a.

(final results of these tests reduced to
a scale where the average is 50)

Mr. A	61
Mr. B	33
Miss C	49 plus
Mr. D	34
Miss E	45
Miss F	65
Miss G	42
Miss H	55
Miss I	66

Spot Pattern Test.

(5 series - 5 arrangements of spots in each series)

Table No. 13.

	7's	8's	9's	9's	10's	total no. of exposures
Miss C	12	14	14	13	11	64
Mr. A	12	13	14	14	14	67
Miss F	20	13	16	14	10	73
Miss I	13	13	20	17	13	76
Miss E	19	15	19	14	18	85
Miss G	18	22	17	16	13	86
MR. D	21	16	18	23	20	98
Miss H	25	23	24	15	20	107
Mr. B	30	26	21	19	21	117

Table No. 13a.

(final results of these tests reduced to
a scale where the average is 50)

Mr. A	62
Mr. B	35
Miss C	65
Mr. D	42
Miss E	49
Miss F	57
Miss G	48
Miss H	38
Miss I	54 plus

Mechanical Ability.

(combination of the two puzzle box tests and the bank test)

Table No. 14.

Puzzle Box.	time required to open	time required to close	total time required
Miss G	1-15	1-40	2-55
Mr. A	1-41	1-42	3-23
Mr. D	3-13	1-30	4-43
Miss F	3-05	3-04	6-09
Miss C	7-03	3-04	10-07
Miss I	8-30	5-40	14-10
Mr. B	6-02	8-40	14-42
Miss H	9-40	6-43	16-23
Miss E	10-45	8-03	18-48

Table No. 14a.

Bank.

(complicated command)

	Time required to open.	
Miss H	1-20	(Command correctly received)
Miss F	1-50	(One order forgotten)
Mr. A	2-20	(Command correctly received)
Miss C	2-40	(Command correctly received)
Mr. B	4-08	(Command correctly received)
Miss I	4-09	(Command correctly received)
Miss G	4-15	(Last two orders forgotten)
Mr. D	5-50	(Command correctly received)
Miss E	11-08	(Two orders forgotten)

Table No. 14b.

(final results of these tests reduced to
a scale where the average is 50)

Mr. A	86
Mr. B	26
Miss C	40
Mr. D	55
Miss E	16
Miss F	63
Miss G	87
Miss H	50
Miss I	27

Fast Forward Reading.

Table No. 15.

	Time (given in seconds)
Miss H	50
Miss I	56
Miss F	60
Mr. A	68
Mr. D	70
Miss C	77
Mr. B	79
Miss G	80
Miss E	80

Table No. 15a.

(final results of these tests reduced to
a scale where the average is 50)

Mr. A	50
Mr. B	43
Miss C	44
Mr. D	47
Miss E	42
Miss F	55
Miss G	42
Miss H	67
Miss I	60

Complicated Prose I
(reading words backward)

Table No. 16.

	Time.
Mr. A	2-44
Miss I	3-14
Miss H	3-52
Miss F	4-16
Miss C	5-53
Miss G	6-30
Mr. D	8-20
Miss E	10-04
Mr. B	16-27

Table No. 16a.

Mr. A	92
Mr. B	16
Miss C	43
Mr. D	31
Miss E	25
Miss F	60
Miss G	39
Miss H	66
Miss I	78

(final results of these tests reduced to a
scale where the average is 50)

Complicated Prose II
(reading letters backward)

Table No. 17.

	Time
Mr. A	5-43
Miss I	10-02
Miss G	10-07
Miss F	10-09
Mr. D	12-30
Miss C	12-46
Miss H	17-45
Mr. B	23-37
Miss E	29-10

Table No. 17a.

(final results of these tests reduced to a
scale where the average is 50)

Mr. A	103
Mr. B	25
Miss C	46
Mr. D	48
Miss E	20
Miss F	58-
Miss G	58
Miss I	59

Scholastic Record.

Table No. 18.

Mr. A	68
Mr. B	40
Miss C	38
Mr. D	32
Miss E	39
Miss F	54
Miss G	60
Miss H	67
Miss I	52

Imputed Intelligence.

Table No. 19.

Mr. A	66
Mr. B	30
Miss C	46
Mr. D	38
Miss E	34
Miss F	68
Miss G	50
Miss H	58
Miss I	60

Tapping.

(average of 5 tests)

Table No. 20.

Right Hand.

Miss F	238.0
Miss I	226.0
Miss C	223.3
Miss H	222.5
Miss G	200.3
Mr. A	196.8
Miss E	196.0
Mr. B	191.3
Mr. D	190.0

Table No. 20a.

(final results of these tests reduced
to a scale where the average is 50)

Mr. A	47 plus
Mr. B	46
Miss C	53 plus
Mr. D	45
Miss E	47
Miss F	57
Miss G	48
Miss H	53
Miss I	54

Treatment of Results and Conclusions.

In the two preceding sections I have described the tests used in determining the subject's powers at a number of different performances, and have also given in convenient tables and graphs the marks made in these tests. We must now consider how to regard these results. The usual method is to pick for each performance a label out of a certain stock of conceptions used for that purpose, such as association, memory, etc. When, for instance, a subject has successfully reproduced a story given as logical memory material, he is straightway declared to be good in all other kinds of memory performances; for this there is no conclusive evidence. On the other hand, if we do not make such a deduction it is at first difficult to see how we are to make any deduction at all. The fact of doing anything well has really demonstrated at most a power for that particular performance only, and as in ordinary life no two performances resemble one another quite exactly, it would seem that no isolated performance could give us precise information for subsequent use.

Evidently, then, the first step toward profitable knowledge must be to find out whether or not performances are interdependent, so that when a subject shows ability in one performance we may be enabled to form some conclusion as to the likelihood of his having ability in another.

At present the only effective method known of measuring such interdependence appears to be that of correlational

coefficients.

In the present paper, therefore, I have used these quite extensively. The results I have obtained in the correlations will be slightly smaller than the true ones. Recent investigations have shown that the ^{raw} correlations are always smaller than the true ones ~~when the averages are derived from a small number of cases.~~

As regards the probable error of the coefficients, I have checked ^{the} ~~by~~ results by Spearman's formula,.

$$P. E. = .6745 \frac{1 - r^2}{\sqrt{n}}$$

r in this formula equals the correlational coefficient and n equals the number of cases (Always 9 in this experiment)

Such, then, is the statistical method by which I hope to decide between the three rival theories. If the theory of 'specific abilities' holds good, ^{the} ~~my~~ correlation between columns of correlational coefficients should average about 0. If the theory of 'levels', or the almost universal belief in 'types' is correct, then the mean correlation between columns should be a low minus value. To make this clear suppose we assume that there are three 'types'; let us designate them by the Roman numerals I, II, and III. Suppose three tests had been chosen from each of these 'types'; let us designate these as I₁, I₂, and I₃, II₁, II₂, and II₃, III₁, III₂, and III₃. In studying the table like the one given here where the correlations between the tests are pooled, we can see

	I ₁	I ₂	I ₃	II ₁	II ₂	II ₃	III ₁	III ₂	III ₃
I ₁		h	h	1	1	1	1	1	1
I ₂	h		h	1	1	1	1	1	1
I ₃	h	h		1	1	1	1	1	1
II ₁	1	1	1		h	h	1	1	1
II ₂	1	1	1	h		h	1	1	1
II ₃	1	1	1	h	h		1	1	1
III ₁	1	1	1	1	1	1		h	h
III ₂	1	1	1	1	1	1	h		h
III ₃	1	1	1	1	1	1	h	h	

Note: In this table h means high correlation; 1 means low correlation. According to the theory the tests within one 'type' will correlate high with one another; those within different 'types' will give a low value when correlated.

that there are two kinds of columns. They are arranged as follows:

Pairs of columns belonging to the same level.	Pairs of columns belonging to different levels.
I ₁ , I ₂	I ₁ , II ₁
h h	h 1
1 1	h 1
1 1	1 h
1 1	1 h
1 1	1 1
1 1	1 1
1 1	1 1

When the columns belong to the same 'type' the high coefficients will come in corresponding places, so that the correlation between the columns will be positive. When the columns belong to different 'types', the high coefficients always come in non-corresponding places, so that the correlation between the columns is negative. Since there are more pairs of columns belonging to different levels than to the same one, one would expect the mean value of the correlation to be low and negative. (See note)

Now, let us return to the three theories. We have seen that the theory of specific abilities demands that the correlations between columns approach 0, and that the theory of 'types' demands a low negative correlation. However, if the true theory is that of a 'general common factor' the correlations between the columns should be positive and high.

By examining the table of correlations given on the following page we can see that the average correlations are high; especially do we find this ^{to be} the case if we remember that these correlations are all the 'raw' figures. If we eliminate ^{certain} ~~these~~ tests ~~in which the probable error is rather high~~, we find that this average is .64 which is a very high figure. [See p. 106]

Note: This proof is based on that given by Hart and Spearman.

See the supplemental file for a full version of this chart.

	104.							
	Log. Memory	Rote Memory	Mem. for Obj.	Free Ass'n.	Cont. Ass'n.	Non. Syl.	Let. for Dig.	Sym. for Let.
Logical Memory.		51	36	86	75	74	87	81
Rote Memory	51		70	63	13	77	59	67
Memory for Objects	36	70		17	-09	45	43	35
Free Association	86	63	17		56	84	80	74
Controlled Association	75	13	-09	56		38	45	60
Learning Nonsense Syllables	74	77	45	84	38		73	71
Learning Letters for Digits	87	59	43	80	45	73		81
Learning Symbols for Letters	81	67	35	74	60	71	81	
Learning Poetry	78	74	45	88	25	88	89	77
Range of letters	41	94	52	60	09	71	50	70
Pictures	72	06	03	66	42	54	54	46
Poetry	84	72	49	88	32	83	89	77
Spot Pattern	54	37	75	24	11	47	51	42
Mechanical Ability	54	03	-05	29	79	68	37	59
Forward Reading	65	65	15	87	43	62	62	58
Complicated Prose I	96	58	41	65	65	76	93	76
Complicated Prose II	75	24	33	48	62	61	72	57
Scholastic Records	81	23	-18	78	84	50	66	74
Imputed Intelligence	94	63	35	91	62	89	74	89
Tapping	56	61	38	70	07	68	47	55
Average	71	52	32	66	42	67	66	66

Note: The figures in the above table are to be read as hundredths.

Poetry-Tach.	Range of Let.	105.		Spot Pattern.	Mech. Ability	Forw'd. Read.	Comp. Prose I		Schol. Records	Imp. Intell.	Tapping.
		" Pictures	" Poetry.				" I	" II			
78	41	72	84	54	54	65	96	75	81	94	56
74	94	06	72	37	03	65	58	24	23	63	61
45	52	03	49	75	-05	15	41	33	-18	35	38
88	60	66	88	24	29	87	65	48	78	91	70
25	09	42	32	11	79	43	65	62	84	62	07
88	71	54	83	47	68	62	76	61	50	89	68
89	50	54	88	51	37	62	93	72	66	74	47
77	70	46	77	42	59	58	76	57	74	89	55
	70	62	97	50	18	69	83	52	55	89	76
70		07	69	30	04	56	46	12	30	60	63
62	07		66	48	36	37	60	49	60	72	69
97	69	66		60	17	67	87	53	61	89	77
50	30	48	60		26	-09	52	62	14	53	41
18	04	36	17	26		01	43	75	61	55	-05
69	56	37	67	-09	01		67	13	56	66	63
83	46	60	87	52	43	67		77	75	91	48
52	12	49	53	62	75	13	77		56	71	06
55	30	60	61	14	61	56	75	56		77	31
89	60	72	89	53	55	66	91	71	77		67
76	63	69	77	41	-05	63	48	06	31	67	
68	47	47	69	40	35	49	68	50	53	72	49

By pooling the averages of the columns we get .55, a figure rather high in itself. But suppose we eliminate the following tests: memory for objects, controlled association, range of letters, range of pictures, spot pattern, mechanical ability, forward reading, and tapping ~~(the probable error in these tests is a little higher than it should be for the results to be absolutely reliable)~~. The average for the remaining tests is .64. In order to make my results more comprehensive, I have also correlated four pairs of columns;

Logical memory with scholastic record .80.

Logical memory with imputed intelligence .77.

Free Association with substituting

letters for digits .62

Learning poetry with complicated

prose number I. .53

This gives an average of .68. These figures, if corrected, would be very high indeed.

The experiment as a whole gives essentially the same results as those found by Abelson, Burt, Hart, and Spearman. When we face the three theories with the results given above, it is at once evident that ~~the most complete~~ ^{same} support is given to the theory of the 'general common factor', while the ~~rival theories are contradicted just as decisively as they were in the English studies.~~ ^{theory of specific abilities receives also some support.}

We must conclude, then, that in general, if an indiv-

individual is good in one thing, he is very apt to be good at other things. Especially is this true if the subject shows decided ability ⁱⁿ the performance at which he is tested. The 'general common factor' will tend to make him proficient in everything undertaken. This is shown on the table given on the following page where the subjects are arranged in each test according to rank. For example, Miss F ranks first when all the tests are pooled together (this grade is based on mere rank order and not on order as would be given by the tables where 50 is an average); she has no rank lower than 4; in fact, she has only three ranks of 4; the remaining ranks are 1, 2, and 3, mostly 1 and 2. In contrast let us consider Mr. B who has the lowest average rank; he has one rank of 6, three ranks of 7, five ranks of 8, and eleven ranks of 9. In order to make our illustrations complete, let us consider Miss G's marks as representative of the work of a medium type of student. She has one rank 1, three ranks of 8, two ranks of 7; her other ranks are 3, 4, 5, and 6. *She is represented* ~~This, it seems to me, in every rank from the highest to lowest except is conclusive evidence that the mind of an individual will ranks 2 and 9.~~ ~~function with pretty near the same degree of efficiency, whatever the task undertaken.~~

Although the 'general common factor' is, as Spearman says, the chief explanation of the facts stated in the above paragraph, still we must not draw the conclusion that it is the only thing which governs our actions. Indeed it would seem that each performance requires certain 'specific abilities' as well as the 'general common factor'.

	A	B	C	D	E	F	G	H	I
	Mr.	Mr.	Miss	Mr.	Miss	Miss	Miss	Miss	Miss
Logical Memory.	1	9	5	7	8	4	6	2	2
Rote Memory	3	9	7	5	5	1	8	2	3
Memory for Objects	2	9	1	2	6	2	8	7	2
Free Association	4	7	6	8	9	2	5	1	3
Controlled Association	1	8	5	6	9	4	3	2	7
Learning Nonsense Syllables	2	8	5	5	9	1	7	4	3
Learning Letters for Digits.	2	9	8	6	7	3	5	4	1
Learning Symbols for Letters	2	9	8	7	6	1	4	2	5
Learning Poetry	3	9	5	8	6	1	6	4	1
Range of Letters	4	9	7	6	3	1	8	2	5
Pictures	5	7	4	9	8	2	3	6	1
Poetry	3	9	5	8	6	2	7	4	1
Spot Pattern	2	9	1	7	5	3	6	8	4
Mechanical Ability	2	8	6	4	9	3	1	5	7
Forward Reading	4	7	6	5	8	3	8	1	2
Complicated Prose I	1	9	5	7	8	4	6	3	2
Complicated Prose II	1	8	6	5	9	3	3	7	2
Scholastic Records	1	6	8	9	7	4	3	2	5
Imputed Intelligence	2	9	6	7	8	1	5	4	3
Tapping	6	8	3	9	6	1	5	3	2
Final Ranking.	2	9	6	7	8	1	5	4	3

These, however, are small (but we are not justified in saying 'insignificant') when compared with the 'common factor'!

The results and conclusions secured by studying the new data of this experiment are ^{in general agreement} ~~almost identical~~ with those secured by Hart and Spearman.

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UNIVERSITY OF MISSOURI
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DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

May 15/13 -

Dear Dr. Miller:

I approve Mr. Brunner's
thesis for the M.A. degree, but before
it is bound I should like to have
the last few paragraphs re-written,

Respectfully

W.H. Ryle

I approve _____

Max F. Meyer

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