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A Study in the Interrelations of Measures of Learning, Five Motor and Two Verbal Problems

Woodrow W. Wilkerson
College of William & Mary - Arts & Sciences

A STUDY IN THE INTERRELATIONS OF MEASURES OF LEARNING - FIVE MOTOR AND TWO VERBAL PROBLEMS

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CONTENTS

CHAPTER I

INTRODUCTION

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INTRODUCTION

The Problem. The problem of learning has received a place of importance in the experimental literature of psychology since the study on memory by Ebbinghaus[1] in 1885. One problem in learning that is attracting psychologists and educators at the present time is the problem of "learning ability" or "learning abilities". Is there a general learning ability which enables a person to learn rapidly, moderately well, or slowly in various learning situations? Or is it true that a person may learn very rapidly in one situation and learn very slowly in another? We have often heard of pupils classified as "good" learners and "poor" learners in school work. Is this dichotomous division basically sound? Does a general learning ability run through all problems of learning? Let us look at the other side of the problem. We have heard often that pupil A is "good" in mathematics but "poor" in English, or that pubil B is "good" in Latin but "poor" in the sciences, or that pupil C is "good" in athletic contests but "poor" in class work. These statements lend support to the idea that learning is specific and relevant only to the particular situation in question. They indicate further that what a person does in one learning situation has little

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[1] Melton, A.W., The Methodology of Experimental Studies of Human Learning and Retention. The Psychological Bulletin 33, 1936. 305.

predictive value of what he will do in another. Is there any experimental evidence which would tend to prove or disprove the theory of a general learning ability or the theory of specific learning abilities? Let us turn to the literature in search of previous studies which relate to the present problem.

The Literature. The literature reveals the fact that a number of investigations or researches have been made which are significant to the present study, even though many of them were concerned primarily with other problems. For the sake of clarity the studies will be divided into three groups, according to the types of tests that were used in the experimental work. The groups are as follows: motor; motor and verbal; and pure verbal. The group that consists of motor studies is divided into two sections: motor studies on humans, and motor studies on animals. These groups will be discussed in the order in which they have been mentioned. The specific studies in each group will be reviewed briefly giving primarily the intercorrelations and tentative conclusions.

The majority of the motor studies covered in the literature have been made on subhuman subjects. However, motor tests have long been of great interest to psychologists and are becoming more and more valuable to educators and teachers. Psychologists have been more concerned with motor ability tests from the standpoint of individual differences and the relation of motor and physical tests of mental ability.(1) The results of the studies

(1) Garrett, H.E., and Schneck, M.R., Psychological Tests, Methods, and Results. New York. Harper and Brothers. 1933. p.58

reported below are presented in chronological order.

Hollingworth[1] in 1913 found coefficients of correlation ranging from -.25 on the first trial to .39 on the two hundred and fifth trial between the coordination test (three hole test) and tapping.

Carothers[2] in a study published in 1921 reported low correlations between the coordination test and 19 simple mental and physical tests. However, he found a correlation of .48 between the coordination test and the tapping test.

Seashore[3] in 1931 designed a group of tests with the idea in mind of predicting success in vocational activities. The intercorrelations between the tests in this group vary from -.03 to .48. The tests in this unit are as follows:

1. The Koerth pursuit apparatus.
2. Motor rhythm, or precision in following a regular rhythm pattern on a telegraph key.
3. Serial discrimeter, or speed of finger movements in discriminative reaction to a visual series.
4. Tapping.
5. Spool packing, involving speed in the coordination of the hands.
6. Speed rotor (Miles) requiring speed in turning a small hand drill.

This battery of tests is not particularly important for the present study; however, Garrett and Schneck's conclusion relative to Seashore's interpretation of the intercorrelations of his tests is

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(1) Hollingworth, H.L., Correlation of Abilities as Affected by Practice. Journal of Educational Psychology 4,1913.405-414.
(2) Garrett, H.E., and Schneck, M.R., Psychological Tests, Methods, and Results. New York. Harper and Brothers. 1933. p.47.
(3) Ibid. p.56.

significant. "Seashore interprets the low intercorrelations of the tests in his battery, as well as their low relationship to his criterion, to mean that motor skills are highly specific".[1]

Some studies on the correlation between intelligence and specific motor problems have been reported. Burt[2], in a study published in 1910, found a correlation of .67 between mirror drawing and teachers' estimates of intelligence on a group of 50 elementary school boys. This relatively high correlation as found by Burt has not been substantiated by other studies.

Calfee[3], in a study published in 1913, reported a correlation of .07 between mirror drawing and school grades of a group of elementary school boys.

Garfiel[4], in a study published in 1923, found a correlation of -.08 between the Army Alpha Intelligence Examination and his Motor Agility Tests. These tests included: 100 yard dash; picking up paper; strength of back; steadiness; tricks; tapping; leg strength, and hand strength.

Spence and Townsend[5](1930), using the high relief finger maze and the Thurstone Intelligence Test, found the correlations to range from -.09 to .52 on two groups of college students.

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(1) Garrett, H.E., and Schneck, M.R., Psychological Tests, Methods, and Results. New York, Harper and Brothers, 1933. p.54.
(2) Ibid. p.103.
(3) Calfee, M., College Freshman and Four General Intelligence Tests. Journal of Educational Psychology 4, 1913. p.227.
(4) Garrett, H.E., and Schneck, M.R., Psychological Tests, Methods, and Results. New York, Harper and Brothers, 1933. p.53.
(5) Ibid. p.103.

Clinton[1] (1930) found correlations which ranged from -.38 to .27 between mirror drawing ability and measures of general intelligence in groups of elementary, high school, and college students ranging from 26 to 87 per group. He concludes that "there is no positive relation between mirror drawing ability and general intelligence".

In summarizing the motor studies on human subjects we find that there is lack of evidence for the existance of a general motor learning ability and no real evidence for a motor group factor. All of the investigators except Burt[2], on the relation of intelligence to the learning of specific motor problems, show low correlations.

Since human motor studies that bear on the present problem are limited, motor studies in animal learning have been included in this thesis. Ten such studies are reported below.

Bagg[3], whose study was published in 1920, found a coefficient of correlation of .11 for errors between a single maze and a multiple choice maze. He used ninety mice as subjects.

Hunter[4] in 1922 made an investigation on the problem of the relationship between ability to form one habit and then break it by forming its opposite. He found a correlation of .36 ± .08 (time) and a correlation of -.02 ± .08 (distance) between

(1)Clinton, K.J., Nature of Mirror-Drawing Ability:Norms on Mirror Drawing for White Children by Age and Sex.Journal of Educational Psychology 21.1930.p.224,228.

(2)Garrett,H.E.,and Schneck,M.R.,Psychological Tests,Methods,and Results. New York.Harper and Brothers. 1933. p.103.

(3) Commins, W.D.,McNemar,Quinn, and Stone,C.P.,Intercorrelations of Measures of Ability in the Rat.Journal of Comparative Psychology 14.1932.p.228.

(4)Hunter,W.S.,Habit Interference in the White Rat and in Human Subjects.Journal of Comparative Psychology 2,1922. p.48.

making and breaking a circular maze habit.

Davis and Tolman[1] in 1924 reported a correlation of .456 (time score) for rats on maze A and B.

The results of Hunter and Randolph's[2] study in 1924 as they throw light on the present study are presented in Table I. They give four correlations for each problem.

Table I.

Showing Intercorrelations on Subhuman Problems (Taken from Hunter and Randolph's Summary from experiments 4 to 14.)

	1	2	3
1.T-Maze		-.16,-.09,.005,.003	-.11,-.08,.09,.52
2.Straight-away Maze			.08,.25,.18,.16
3.Problem Box			

Table 1 shows no significant intercorrelations. It will be noted that contrary to what might be expected, the T-Maze and the Straight-away Maze have correlations of practically zero.

Lashley[3], whose work was published in 1929, reports a correlation of -.09 for time, -.36 for errors, and -.38 for trials between two mazes, one the reverse pattern of the other, and the other an elevated maze.

Williams[4], in a work published in 1929, for two groups

(1)Davis,P.C.,and Tolman,E.C.,A Note on the Correlations Between Two Mazes. Journal of Comparative Psychology 4,1924. p.129.
(2)Hunter,W.S.,and Randolph,Vance, Further Studies on the Reliabilities of the Maze with Rats and Humans.Journal of Comparative Psychology 4, 1924. p.456.
(3)Commins, W.D.,McNemar,Quinn,and Stone,C.P.,Intercorrelations of Measures of Ability in the Rat.Journal of Comparative Psychology 14, 1932.p.228
(4) Ibid.p.228.

of 26 rats each reported coefficients of correlation of .16 and .08 between a discrimination box and a 14 unit T-Maze.

Miles[1] in 1930 using 58 rats found results that are contrary to the results of Hunter and Randolph. Miles found a correlation of .60 ± .06 for trials, .60 ± .08 for errors, and .67 for time between an alley maze and an elevated maze.

Tryon[2] in 1931 found a correlation of approximately .8 between errors made by 141 rats in running two T-Mazes. The correlation which Commins, McNemar, and Stone[3] found in 1932 on a group of 44 rats was the control group.

Table II.

Showing Intercorrelations taken from Commins, McNemar, and Stone's table - Intercorrelation of the four instruments used in the Castration Study.

	1	2	3	4
1. Multiple Maze		-.10	.77	.64
2. Light Box			-.02	.04
3. Elevated Maze U Type				.65
4. Elevated Maze T Type				

They state that the intercorrelations of the three mazes in the vicinity of .6, "considering the restricted range may be taken as indicative of a maze learning ability".[4] Table II shows further that a light discrimination habit is not related to the performance on any of the three mazes. Commins, McNemar, and Stone

(1)Miles,W.R.,The Comparative Learning of Rats on Elevated and Alley Mazes of the Same Pattern.Journal of Comparative Psychology 10,1930.p.255.

(2)Tryon,R.C.Studies in Individual Differences in Maze Ability III The Community of Function Between Two Maze Abilities.Journal of Comparative Psychology 12,1931.p.114.

(3)Commins, D., McNemar, Quinn, & Stone, C., Intercorrelations of Measures of Ability in the Rat.Journal Comparative Psychology 14.1932.p.231.

(4)Ibid.p.234.

also report correlations ranging from -.22 to .19 with a T-maze.

The results of Tomilin and Stone's[1] study, published in 1934, are given in Table III. The authors used 168 female and 168 male albino rats. Table III is a reproduction of their table entitled "Intercorrelations of Total Error Scores from the Six Learning Situations".

Table III
Intercorrelations of Total Error Scores from the Six Learning Problems.

Test	Rel. O. vs. E.	S.D.	RWUM	EL.M	REL.M	LD	RLD
1.WUM	.95 .005	37.09	.55±.04	.47±.04	.35±.05	.05±.06	-.05±.06
2.RWUM	.88 .012	12.92		.52±.04	.41±.05	-.05±.06	-.19±.05
3.EL.M	.71 .036	12.65			.51±.04	-.01±.06	-.12±.06
4.REL.M	.50 .056	6.15				.09±.06	.00±.06
5.LD.	.66 .038	8.39					.52±.04
6.RLD	.95 .066	29.82					

All of the above intercorrelations are not corrected. The symbols and corresponding tests are as follows: WUM, Modified Warden Maze; RWUM, Modified Warden Maze, reversed pattern; EL.M, Elevated Maze; REL.M, Elevated Maze (reversed); LD, Multiple Light Discrimination Apparatus; RLD, Multiple Light Discrimination Apparatus (reversed). Table III shows fairly high correlations for each of the maze problems, a good correlation between the two light discrimination problems, but low correlations between maze and light discrimination. These results are in agreement with the results as shown in Table II. Tomilin and Stone conclude that their study "confirms the results of previous studies, clearly suggests that light discrimination and the maze measure different learning functions".[2]

(1) Tomilin, Mihail I., and Stone, Calvin P., Intercorrelations of Measures of Learning Ability in the Albino Rat. Journal of Comparative Psychology 17-18, 1934.
(2) Ibid. p.87.

In an attempt to summarize this material on subhuman motor learning, we find that six of the investigators (Hunter, Davis and Tolman; Miles; Tryon; Commins, McNemar and Stone; and Tomilin and Stone) obtained correlations ranging from .56 to .80 for the various maze tests. Bagg, Hunter, and Randolph, and Bashley found correlations ranging from .11 to -.38 for maze tests. Thus the majority of the studies would indicate that there is a general maze ability for rats. The studies of Williams, McNemar, Commins, Stone, and Tomilin and Stone, point out that there is no significant relationship between light discrimination ability and maze ability. A tentative conclusion suggested by these studies is that there are indications of a general maze learning ability, but when light discrimination, platform box and maze scores are correlated, there is evidence of specific motor learning abilities in subhuman subjects.

We turn next to those studies on human subjects which have included both motor and verabl problems in the experimental work. Five significant studies by the following men: Pyle(1), Garrett(2), Gundlach(3), Hall(4), and Shelburne(5), will be reviewed briefly.

(1) Shelburne, T.P., A Preliminary Study in General Learning Ability. Unpublished Master's Thesis, College of William and Mary. 1937. p.18.
(2) Garrett, H.E., The Relatipnship of Tests of Memory and Learning to Each Other and to General Intelligence in a Highly Selected Adult Group. Journal of Educational Psychology 19, 1928. p.601-615.
(3) Gundlach, Ralph, The Effects of Practice on the Correlations of Three Mental Tests. Journal of Educational Psychology 17. 1926. p.395.
(4) Hall, Calvin S., Intercorrelations of Measures of Human Learning. Psychological Review 43, 1936. p.179-196.
(5) Shelburne, P.T., A Preliminary Study in General Learning Ability. Unpublished Master's Thesis, College of William and Mary, 1937.

The results of Pyle's experiment (1919) are shown in Table IV. Pyle's purpose was to determine whether learning ability is constant for different types of material and also to determine the degree of interrelation between scores obtained on different learning problems. He used four learning problems: substitution (digit-symbol, symbol-digit, and alphabet-symbol); nonsense syllabes; card sorting; marble sorting.

Table IV.

Showing Intercorrelations

	1	2	3	4
1. Substitution		.45	.60	.62
2. Nonsense Syllables			.59	.45
3. Card Sorting				.26
4. Marble Sorting				

In another study which refers to the above study, Pyle[1] gives average correlations. Table V is a reproduction of his table.

Table V.

Showing the Average Correlation of Each of Five Types of learning with Other Types

Types of Learning	Average of Correlations
Digit Substitution	.594
Alphabet Substitution	.547
Nonsense Syllables	.441
Card Sorting	.496
Marble Sorting	.503
Average of All	.516

Pyle reports that a raw correlation of a little more than .6 indicates a very high positive relationship between the abilities

(1)Pyle, W.H., The Psychology of Learning. Baltimore, Warwick and York, Inc. 1928. p.220-225.

required to learn the different types of material. He states further in reference to a general learning ability, "if the disturbing factors could be eliminated, the correlation would be unity".(1) Pyle is the only investigator who makes such an assumption. This assumption will be discussed at the end of the section on human motor and verbal learning.

Garrett(2) in 1926-26 made a study on eight tests of memory and learning. He used 158 college men. The average age of the group was 19.4. Five of the tests which he used were designed primarily to measure immediate memory. Only correlations of three tests (learning tests) have been recorded in table VI. These correlations are taken from Garrett's Table I - Intercorrelations of Eight Memory Tests, Etc.(3)

Table VI.

Showing Intercorrelations and Reliability Coefficients in Parentheses

	1	2	3	4
1. Thorndike, Examination	(.86)	.09	.37	.31
2. Digit Symbol		(.95)	.291	.67
3. Turkish-English Vocabulary			(.91)	.39
4. Code Learning				(.85)

It will be noted that the only significant correlation is .57 between the digit-symbol test and the code learning test. Cor-

(1)Pyle, W.H., The Psychology of Learning. Baltimore. Warwick and York, Inc. 1928. p.222.
(2)Garrett, H.E., The Relationship of Tests of Memory and Learning to Each Other and to General Intelligence in a Highly Selected Adult Group. Journal of Educational Psychology 19. 1928. p.601-613.
(3)Ibid. p.603.

relations for the eight problems range from -.12 to .69. However, Garrett draws a tentative conclusion that the correlation between the eight problems show that there is a small memory factor present.[1]

Gundlach[2] (1926), working with 39 college students on the effect of practice on the correlations of three mental tests, did not find that the results would indicate that "intercorrelations increase with practice, due to a more accurate tapping of ultimate capacity or general ability".[3] Average correlations for trials 6-10 and 21-25 are found in Table VII.

Table VII.

Showing Average Intercorrelations for Trials 6-10 and Trials 21-25, Respectively

	1.	2.	3.
1. Number Series		.43 and .65	.50 and .47
2. Cancellation			.39 and .47
3. Multiplication			

Hall[4] (1936) made an investigation concerning the intercorrelations between four learning problems , usint one hundred college sophomore women. The age range of this group was from 18 years and seven months to 19 years and five months. The cor-

(1)Garrett, H.E.,The Relationship of Tests of Memory and Learning to Each Other and to General Intelligence in a Selected Adult Group.Journal of Educational Psychology 19.1928. p.613 .
(2)Gundlach, Ralph, The Effects of Practice on Correlations of Three Mental Tests.Journal of Educational Psychology 17.1926.p.395.
(3)Ibid. p.401.
(4)Hall, Calvin S.,Intercorrelations of Measures of Human Learning. Psychological Review 43, 1936.p.179-196.

relations which he obtained are found in Table VIII.[1]

Table VIII.

Showing Intercorrelations (Corrected) and Probable Errors.

	1.	2.	3.	4.
1. Punchboard Maze		.40±.06	.30±.07	.34±.06
2. Rational Learning			.29±.07	.16±.07
3. Stylus Maze				.11±.07
4. Nonsense Syllables				

Hall's interpretation of these correlations is as follows: "Although the results of the present and previous studies point to a high degree of specificity in learning, the writer believes that a general learning ability of some importance might be discovered were we able to control the differential influence of motivation and previous practice in the learning situation."[2]

The results of Shelburne's[3] work (1937) at the College of William and Mary with twenty-eight college students is shown below in Table IX.

Table IX.
Showing Intercorrelations for Problems in Learning
(A reproduction[4])

	1.	2.	3.	4.	5.	6.
1. Substitution.		.34±.16	.27±.17	.40±.15	.21±.17	.045±.16
2. Hawaiian			.70±.09	.58±.13	-.02±.18	.31±.17
3. Nonsense				.59±.14	-.03±.18	.37±.16
4. Poetry					-.16 ± .18	-.004±.19
5. Maze						.34±.16
6. Alphabet						

(1) Hall, Calvin S., Intercorrelations of Measures of Human Learning. Psychological Review 43. 1936. p.192.
(2) Ibid. p.195.
(3) Shelburne, P.T., A Preliminary Study in General Learning Ability. Unpublished Master's Thesis, College of William and Mary. 1937
(4) Ibid. p.55

Shelburne concludes from his study that "it does not appear that we can present any evidence for a general factor that runs through all learning".[1] "There is good evidence to indicate a group factor which runs through the learning of nonsense syllables, poetry, and vocabulary".[2]

Considering these studies as a group, there is no definite evidence in support of a general learning ability. However, there is a suggestion in some of the studies that there is a group factor present in the learning of certain kinds of tests. Pyle[3] alone suggests that there is unity in all learning. This, of course, is an assumption. Such an assumption cannot be made on a limited number of tests in the field of learning. Also, his work is one of the first studies on intercorrelations of tests in human learning and he was not fortunate enough to have improved techniques of administration, scoring, and statistical methods at his disposal. Goundlach suggests the possibility of a group factor present in the learning of number series and multiplication. (Table VII.) Garrett found a correlation of .57 between digit-symbol and code learning. (Table VI.) Shelburne indicates (Table IX) that there is a group factor present in the learning of nonsense syllables, poetry, and vocabulary.

Experimental studies consisting entirely of verbal

(1) Shelburne, T.P., A Preliminary Study in General Learning Abilities. Unpublished Master's Thesis, College of William and Mary, 1937. p.58.
(2) Ibid. p.59.
(3) Pyle, W.H., Psychology of Learning. Baltimore, Warwick & York, Inc. 1928. p.222

problems are rather limited. The literature reveals that at least two major studies have been made--one relating to the present problem and the other directly concerned with it.

Anastasi[1], in a study on immediate memory published in 1930, found some interesting results. She used 225 college students as subjects. Eight memory tests were used: paired associates (work-word, form-number, and color-word), digit span, retaining numbers recognition of geometrical forms, and nonsense syllables. Anastasi concluded that there is evidence for the presence of a general factor in these tests. In a second study, published in 1932, Anastasi[2] found distinctly different results from her first study. In her second study she used four memory tests; two tests of numerical ability and two tests of verbal ability (vocabulary and analogies). The correlations found were low or negative. She concluded that a general memory factor, as was indicated by her first study, does not run through all forms of memory. This conclusion of immediate memory is in harmony with most of the literature on motor and verbal learning.

Dr. Henneman[3] of the College of William and Mary has made the most recent study on the problem of intercorrelations of learning scores. The results which he obtained are consistently higher than those obtained in any study thus far. College students

(1)Anastasi, Anne., A Group Factor in Immediate Memory. Archives of Psychology Number 120. 1930. pp.1-61.
(2)Anastasi, Anne, Further Studies on the Memory Factor. Archives of Psychology Number 142. 1932. pp.1-60.
(3)Henneman, R.H., A Study in Verbal Learning. Paper Read Before the Annual Meeting of the Southern Association of Philosophy and Psychology. Knoxville, April, 1938.

were used as subjects. The following verbal problems were used: nonsense syllables; group of meaningful words; Malayan vocabulary; prose (ideas) and prose (verbatim). Coefficients of correlations between these problems were found to range from .55 to .72. The results of this study suggest that there is a general verbal learning ability or certainly a group factor present in all of the above mentioned problems.

The studies on the interrelations of measures of learning, when considered from the standpoint of size of correlation, coefficients, are not in complete agreement. However, this probably should not be surprising because the same method of scoring was not used consistently and there has been a lack of similarity in statistical treatment. In spite of these differences, the motor studies seem to indicate that motor learning is specific; the subhuman studies point to a general maze learning ability, but the maze ability does not correlate highly with performance on other tests; the studies within the verbal range present fairly high correlations in the majority of cases, but generally low correlations are given between motor and verbal learning problems.

The Aim of the Present Study. The purpose of the present study is to obtain information regarding the nature of learning ability. This will be attempted by administering certain motor and verbal learning tests and determining the intercorrelations

of results. These intercorrelations will be used as evidence to indicate the type of learning ability involved.

CHAPTER II

THE PRESENT STUDY

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Nature of the Learning Problems. Seven problems (five motor and two verbal) were selected from a great number of learning problems. The problems are: cancellation; speed of manipulation; maze; cup and ball; mirror-drawing; nonsense syllables; and prose (verbatim). These were selected on the following bases: problems which could be scored similarly; problems in which there could be similar criteria of mastery; problems of wide variability as to type, or problems which overlapped little or none in the measuring of the same performance. This last criterion is particularly significant for the present study, because if reasonably high correlations were found among the various tests, there would be an indication of a general learning ability; or, if a cluster of reasonably high correlations were found, this would be an indication of a group factor. If low or negative correlations were found, there would be an indication of specific learning abilities.

The cancellation test, a simple motor test, was the first administered. This test consists of a prose paragraph which contains 28 a's and 53 i's to be cancelled as quickly and accurately as possible.(1)

The speed-of-manipulation test consists of a board fifteen inches square with thirty-six holes colored in a certain

(1)Administration and further description of each problem can be found in the appendix.

order (black, white, green, and red) and thirty-six correspondingly colored stoppers. This test requires the subject, using only one hand, to match each hole with a proper stopper as rapidly as possible. Since there are only thirty-six stoppers, the subject corrects his errors as he proceeds.

The maze is an elevated wire finger maze consisting of one connected pathway from beginning to end with twelve alleys. This test requires each subject to make two perfect scores in succession within a certain time limit.(1)

The cup-and-ball test requires each subject to make two perfect scores in succession within a certain time limit.(2) In order to make a perfect score on a trial, the subject must catch the ball in the cup ten times in succession.

The mirror-drawing test consists of the drawing box, a mirror, and mimeographed copies of a double star. This test requires the subject to draw a third star within the double star in a time limit(3) with no errors. In order to make no errors, the subject must touch neither inside nor outside outline of the double star.

The nonsense test consists of ten nonsense syllables to be learned perfectly. These were exposed serially, two seconds for each syllable. After the ten were exposed, each subject was given a certain time limit within which to write them from memory.

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(1) See Table X
(2) Ibid.
(3) Ibid.

The time limit was increased arbitrarily with each trial. Nonsense syllables have been used frequently in studies of this type. According to Pyle, "Nonsense syllables, properly constructed and arranged, furnish us with one of the best means of measuring learning capacity.....The material has the advantage that it is absolutely new to experience. The association must be established ab novo".(1)

The prose test consists of a selection of fifty words in length taken from a history textbook with which the subjects were not familiar. This test requires that the subject reproduce the selection perfectly twice in succession. Time is held constant for each subject, but not on each trial.

Reliability of the Measures. The reliability coefficients for the total time score on the motor tests were obtained by correlating the sum of the scores on the odd trials with the sum of the scores on the even trials. Since time was held constant on the two verbal tests, it was necessary to correlate the sum of the error scores on the odd trials with the even trials. The odd scores were correlated with the even scores by the Spearman rank-difference formula.(2)

It would be expected that the reliability coefficients would be high since each trial was a re-test of the previous trial.

(1) Pyle, W.H., The Psychology of Learning. Baltimore, Warwick and York, Inc. 1930. p.228-229.
(2) Garrett, H.E., Statistics in Psychology and Education. New York. Longmans, Green, and Company. 1926. pp.190-192.

According to Spearman, the reliability coefficient is the "correlation between the sums of scores made on odd and even comparable independent (non-identical) tests".[1] However, for the purpose of the present study, it seemed that the most suitable and convenient method of obtaining the reliability of the measures was by correlating the sums of the odd scores with the sums of the even scores.[2] The odd and even scores were correlated by Spearman's rank-difference formula.[3] The reliability coefficients obtained are as follows: cancellation, .96; speed of manipulation, .99; maze, .97; cup and ball, .98; mirror-drawing, .93; nonsense, .94; prose, .97.

The subjects. When the investigation was begun, forty-nine high school pupils, sophomores, junior, and seniors, volunteered to act as subjects. An intelligence test was given to this group, and the thirty-five pupils making the highest scores were selected as subjects. This gave a group consisting of thirteen boys and twenty-two girls, ranging in ages from fifteen years and no months to eighteen years and eight months. The median was sixteen years and five months. Most of the studies on human learning have dealt with adult subjects or subjects of at least eighteen years of age. Consequently, it seemed fitting

(1) Melton, A.W., The Methodology of Experimental Studies of Human Learning and Retention. The Psychological Bulletin 33. 1936. p. 369.
(2) Ibid. p. 368.
(3) Garrett, H.E., Statistics in Psychology and Education. New York. Longmans, Green, and Co. 1926. pp. 190-192.

that a study be made on subjects of high school age. "Theoretically, the problems of learning at any one developmental level are neither more nor less important than those at any other. For an all inclusive and systematic psychology of the growth of human learning ability, it is essential that there be at least a large number of studies for each age".(1)

The Intelligence Test. According to the results of the Henmon-Nelson Tests of Mental Ability, Form A, each of the thirty-five subjects is at least of average ability or above average ability. The validity of the Henmon Test has been obtained by comparing it with other tests. Several correlations have been obtained as follows: Terman Group Test (I.Q.'s), .858; Otis Self-Administering Test (Scores), .810; Kuhlmann-Anderson Test (I.Q.'s), .84. The reliability coefficients for ages 15, 16, and 17 have been found to be .936, .915, and .918, respectively.

Motivation and Emotional Adjustment. It was realized that one of the most important factors that affects the relations between learning performances is motivation. Before the investigation was begun, the subjects were called together, the nature of the study was explained, and an attempt was made to insure a feeling of ease and a desire to do one's best on each problem. As a means of motivation, it was announced that fifteen points would be given each subject on one final examination if he would do his best throughout the experiments. An attempt was made throughout the experiment to see that each subject was not

(1) Corey, Stephen M., A Summary of Certain Factors in Current Investigations on Learning and Memory. American Journal of Psychology 44. 1932. p.191.

disturbed by the novelty of being a subject in an experimental situation and to see that the subject was not discouraged by poor performance. At the beginning of each test the subject was reminded and urged to do his or her best. Quite frequently encouraging remarks were made between trials. Another method used in establishing naturalness in the experimental situation was to give practice on problems which were not included in an actual study. The writer feels that a high degree of interest was maintained throughout the experiments as was indicated by the remarks of the subjects about the tests and by theapparent eagerness with which each began the tests.

Fore-practice or Adjustment Period. Before any of the several tests were given which have been discussed above, a certain number of trials or practice was given each subject on similar tests. Ten trials were given each subject on a short cancellation test; ten trials were given each subject on a speed of manipulation board; five trials were given on Case A; complete learning was required for six nonsense syllables and a short prose passage of thirty-three words. As was mentioned above, this seemed to be an excellent means of bringing about a feeling of ease or naturalness and the establishment of the proper emotional adjustment.

Number of Trials. No set number of trials was required for each pupil, and time was not held constant except in the case of the two verbal problems. Each subject was given trials on the

motor problems until the learning curve tended to level off. The verbal problems were given until each subject could give two successive errorless performances.

Scoring. It seemed more desirable to use the method of common points of mastery[1] in interpreting learning ability on these problems than the traditional percentage method or the method of absolute gain. If subject A improves from a score of thirty to a score of sixty during a certain test, according to the percentage method his improvement is one hundred per cent of the initial score. If subject B improves from a score of twenty to a score of fifty, his improvement is one hundred and fifty per cent of the initial score. According to the percentage method, subject B is the best learner; however, if the method of absolute gains is used, the subjects are equal. "The percentage method is invalid because it assumes that the arbitrary zero point of the test coincides exactly with the absolute zero point of the ability being considered".[2] The absolute gains method is invalid because it assumes that the ability of subject A and B is equal at the start. The common points of mastery technique, method A, consists of selecting some initial point at which, or within a limited range of which, all of the subjects start, and selecting a final point which all of the subjects achieve through a varied number of trials. Learning

(1)Huch, Floyd L., The Method of Common Points of Mastery as a Technique in Human Learning Experimentation. Psychological Review 43. 1936. pp.229-234.
(2)Ibid. p.229.

is then interpreted in terms of the improvement from the initial common point to the final common point. In this investigation scoring is in terms of total time. Table X shows the common points for each problem and the method of scoring.

Table X is shown on the following page.

Table X.

Common Points and Method of Scoring
For Each of the Seven Problems

Problem	Initial Common Point	Final Common Point	Scoring
Cancellation	1st trial on which each subject used between 55 and 60 seconds inclusive.	2nd of 2 successive trials of 50 to 55 seconds (inclusive) with no more than four errors.	Total Time
Speed of Manipulation	1st trial on which each subject used between 52 and 56 seconds inclusive.	2nd of 2 correct trials in succession of 36 to 40 seconds inclusive.	Total Time
Maze	1st trial on which each subject used between 60 and 70 seconds inclusive.	2nd of 2 correct trials in succession of 25 to 30 seconds inclusive.	Total Time
Cup and Ball	1st trial on which each subject used between 50 and 60 seconds inclusive.	2nd of two correct trials in succession of 15 to 20 seconds inclusive.	Total Time
Mirror	1st trial on which each subject used between 95 and 105 seconds inclusive.	1st correct trial of 60 to 70 seconds inclusive.	Total Time
Nonsense	Zero assumed (Note)	2nd of 2 correct trials in succession.	Total Time
Prose	Zero assumed (Note)	2nd of 2 correct trials in succession	Total Time

Note - Complete lack of knowledge of the contents of the test is assumed.

Each subject was penalized one second for each error not corrected in the cancellation test. No penalty for errors was placed on the subjects performance in any other test, because he or she necessarily had to correct all errors before making a perfect score. It will be observed from Table X that at least one or two perfect scores in succession within a certain time limit was required of each subject on all tests except the cancellation test. A perfect score was not required in this test because each subject concentrated on completing the test as quickly as possible, hence, some errors resulted. However, each subject had to meet the criterion of performing with not more than four errors within thirty to thirty-five seconds on two trials in succession. Extropolation from the learning curves was necessary for some subjects in order that their scores might fall within the common points of mastery. Extropolation was necessary more frequently in the cup and ball problem than in any other. It will also be noted from Table X that there is a limited range for each initial and final common points of mastery. A limited range was necessary since all subjects did not use exactly either fifty-five or sixty seconds as in the cancellation test, or fifty-two or fifty-six seconds as in the speed of manipulation test, etc. Zero ability for the two verbal tests was assumed on the ground of total unfamiliarity with the contents of the tests on the part of the subjects.

CHAPTER III

THE RESULTS

CHAPTER III.

THE RESULTS

As has been indicated before in this study, all tests were scored in terms of total time that was required by the subject to progress from an initial common point to a final common point of mastery. Thus the smallest score of each of the learning tests is considered the best, while the largest score on the intelligence test is the best. The raw score on each problem, the raw score on the intelligence test and the age of each subject, are given in Table XI. Each figure represents the total number of minutes required by each subject to reach the given criterion on each problem.

Table XII gives the rank of each student on the intelligence test and on each problem; e.g., subject number 1 ranked first on the Henmon-Nelson Test, and fifteenth, twenty-ninth, tenth, third, fifth, fourth, and second on the cancellation, speed of manipulation, maze, cup and ball, mirror-drawing, nonsense syllables, and prose test, respectively.

Table XIII gives the rank on the intelligence test, the average for the rank standing of each subject on the motor problems, the motor rank, the average for the rank standing on the verbal tests, the verbal rank, the average standing on all the problems, and the final rank on all the problems. Subject number 1 ranked first on the intelligence test, made an average

standing of 12.4 on the five motor problems, thereby making a motor rank of seven; made an average standing of 3.0 on the verbal problems, thereby making a verbal rank of one, and made an average on all the problems of 9.71, thereby obtaining the final rand of two. Column four was obtained by averaging the rank of each student as found in column four through eight of Table XII. Column five was obtained from the ranking of the subjects' average standing in column four. Column six was obtained by averaging the rank of each subject in columns nine and ten of Table XII. Column seven was obtained from six. Column eight is the average made by each subject on all seven problems. Column nine, the final rank column, was obtained from column eight.

Table XIV gives the intercorrelations. These correlations were obtained by the Pearson Product-Moment Method.(1) Table XV shows the correlations corrected for "attenuation" and the probable error(2) for each correlation. The raw correlations were corrected for "attenuation" by the Spearman formula.(3) It is important to note that this table shows relatively low or negative correlations between the motor problems except a correlation of .46 between the maze and mirror-drawing

(1)Dashiell, J.F., Fundamentals of General Psychology. New York. Houghton-Mifflin Co. 1937. pp.301-303.
(2)Garrett, H.E., Statistics in Psychology and Education. New York. Longmans, Green and Co., 1926. p.170.
(3) Ibid. pp.211-213.

test, low or negative correlations between the motor problems and the verbal problems, and a fairly high correlation between the two verbal problems.

Table XVI gives the correlation of intelligence with each of the learning problems, with the rank standing on the motor problems, with the rank standing on the verbal problems, and with the final rank on all problems. Each correlation was obtained by the Spearman Rank-Difference Method and the resulting p (correlation) was changed to Pearson's corresponding r (correlation).(1) It is interesting to note that the highest correlations with intelligence were obtained between the two verbal problems while there are very low correlations between each of the motor tests and intelligence. Also, the highest rank standing correlation is with the verbal problems.

By means of the Spearman Rank-Difference Method, rank standing on the motor problems was correlated with the rank standing on the verbal problems. The correlation obtained was .27±.11.

(1) Garrett, H.E., Statistics in Psychology and Education. New York, Longmans, Green and Co., 1926, pp.190-192.

TABLE XI.

Raw Scores on the Seven Problems
and Herman-Nelson Intelligence Test

Sub.	Age	Herman-Nelson Score	1. Cancel-lation	2. Speed of M.	3. Maze	4. Cup & Ball	5. Mirror	6. Cons.	7. Prose
1	17-11	78	16	19	10	6	19	8	12
2	16-5	68	32	12	12	12	22	8	19
3	17-11	46	7	10	10	20	21	5	25
4	16-5	47	18	12	14	30	20	20	44
5	16-7	51	17	20	14	10	23	12	10
6	16-8	41	12	11	13	19	27	17	25
7	17-4	58	18	16	22	15	31	12	28
8	18-5	45	13	15	9	5	14	23	39
9	16-0	55	27	25	17	21	31	20	30
10	17-2	50	14	9	24	17	33	7	21
11	15-7	50	12	9	9	16	23	10	30
12	16-4	60	13	10	17	12	19	12	21
13	15-4	54	20	18	12	11	19	11	28
14	16-7	47	15	15	15	9	19	16	32
15	15-8	43	19	14	18	10	19	8	28
16	15-0	61	12	8	8	21	20	11	19
17	15-7	54	18	10	8	14	24	12	28
18	17-6	66	17	21	13	20	34	17	21
19	16-6	45	18	17	20	12	24	22	28
20	18-6	60	16	27	8	8	22	10	16
21	16-4	43	20	6	11	18	19	16	32
22	15-8	66	23	17	13	16	19	9	23
23	16-2	41	12	13	22	7	22	13	39
24	17-0	46	9	13	15	9	23	10	21
25	17-0	63	24	17	9	16	18	8	21
26	17-1	40	11	14	8	13	16	7	28
27	17-0	55	10	20	9	4	21	12	19
28	17-8	56	22	7	11	21	18	23	44
29	17-7	66	18	5	12	16	33	10	36
30	15-4	61	17	14	13	17	28	13	16
31	16-2	52	26	7	13	11	20	11	21
32	17-2	49	16	14	16	17	27	16	30
33	16-7	41	15	22	8	17	25	17	56
34	15-5	42	21	18	19	24	21	24	39
35	16-1	56	15	16	17	12	28	8	30
M	16-5	52.06	16.77	14.31	13.42	14.37	22.71	13.14	27.22

Table XII

Rank Scores on the Seven Problems and Henmon-Nelson Intelligence Test

1. Sub.	2. Age	3. Henmon-Nelson Score	4. 1. Cancelation	2. Speed of M.	5. 3. Maze	6. 4. Cup & Ball	7. 5. Mirror	8. 6. Nons.	9. 7. Prose
1	17-11	1	15	29	10	3	5	4	2
2	15-5	2	35	12	14	12	18	4	5
3	17-11	25	1	8	10	29	15	1	16
4	16-5	23	16	12	22	35	12	30	33
5	15-7	19	20	30	22	8	21	17	1
6	16-8	32	5	11	17	28	29	26	16
7	17-4	17	23	26	33	16	31	17	18
8	16-5	28	9	20	6	2	1	33	30
9	16-0	11	34	34	26	31	31	30	28
10	17-2	20	11	6	35	23	23	2	6
11	15-7	20	5	6	7	20	21	10	23
12	16-4	6	9	6	26	12	5	17	6
13	15-4	15	27	26	14	10	5	14	18
14	16-7	23	15	20	24	6	5	24	27
15	15-8	30	26	16	29	8	5	4	14
16	15-0	4	5	5	1	31	12	14	5
17	15-7	15	16	8	2	18	25	17	13
18	17-6	9	20	32	17	29	35	26	8
19	16-6	26	28	23	32	12	25	32	15
20	18-6	6	16	35	8	5	18	10	8
21	16-4	30	27	2	12	27	5	28	27
22	15-8	11	31	23	17	20	5	9	14
23	16-2	32	5	14	33	4	18	22	30
24	17-0	26	2	14	24	6	21	10	8
25	17-0	3	32	25	7	20	3	4	8
26	17-1	35	4	15	4	16	2	2	18
27	17-0	11	8	30	7	1	15	17	5
28	17-8	8	30	3	12	31	3	33	33
29	17-7	11	25	1	14	19	33	10	29
30	15-4	4	20	16	17	23	21	22	3
31	15-2	18	33	3	17	10	12	14	8
32	17-2	22	16	16	29	23	29	24	23
33	16-7	32	15	33	5	23	27	28	35
34	15-5	26	29	26	29	34	15	35	30
35	16-1	9	15	22	28	12	18	6	23

Table XIII.

Rank Standing on Henmon-Nelson Intelligence Test, Motor, Verbal, and on All Problems

1. Sub.	2. Age	3. Henmon-Nelson Standing	4. Average for Motor	5. Motor Rank	6. Average for Verbal	7. Verbal Rank	8. Average, Learning Problems	9. Final Rank
1	17-11	1	12.4	7	3.0	1	9.71	2
2	16-5	2	18.2	22	4.5	2	14.29	12
3	17-11	25	12.6	8	8.5	6	11.43	5
4	16-5	23	19.4	26	31.5	32	22.86	29
5	16-7	19	20.2	27	9.0	7	17.00	18
6	18-8	32	15.0	20	21.0	24	15.86	25
7	17-4	17	26.8	34	17.5	21	23.43	30
8	18-5	26	7.6	1	31.5	32	14.43	13
9	16-0	11	31.2	35	26.5	29	29.86	35
10	17-2	20	21.8	29	6.0	3	16.86	17
11	16-7	20	11.8	6	16.5	19	13.14	9
12	18-4	6	12.0	6	12.5	15	12.14	6
13	15-4	15	15.4	17	16.0	18	16.29	16
14	16-7	23	14.0	11	25.5	27	17.29	20
15	15-8	30	16.8	18	9.0	7	14.57	14
16	16-0	4	10.8	3	9.5	10	10.43	3
17	16-7	15	13.8	10	17.5	21	14.86	15
18	17-8	9	26.6	32	17.0	20	23.86	32
19	16-6	26	23.6	31	25.0	26	24.00	33
20	16-6	8	15.4	13	6.5	5	12.86	8
21	16-4	30	15.6	15	27.5	30	19.43	24
22	15-8	31	12.2	5	31.5	32	17.00	18
23	16-2	32	18.4	25	31.5	32	22.86	29
24	17-0	28	13.4	9	9.0	7	12.14	6
25	17-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
26	[illegible]	33	16.2	19	16.00	17	16.00	12
27	17-8	11	11.2	4	11.0	12	11.14	4
28	17-8	8	10.8	16	33.0	33	20.71	27
29	17-7	11	16.0	20	19.5	23	18.43	26
30	16-8	6	19.0	23	12.5	15	17.43	21
31	16-2	16	16.4	19	11.0	12	15.57	10
32	17-2	22	22.0	30	23.0	25	22.86	29
33	16-7	32	20.6	28	30.5	31	23.43	30
34	16-8	20	20.0	32	32.5	34	26.29	34
35	16-1	9	19.0	23	13.5	17	17.43	21

Table XIV.

Intercorrelations for Problems in Learning

	1.	2.	3.	4.	5.	6.	7.
1.Cancellation		.09	.11	.12	.05	.16	-.03
2.Speed of Manip.			-.0009	-.19	.10	.10	-.13
3.Maze				.03	.44	.12	.03
4.Cup and Ball					.26	.54	.36
5.Mirror						-.011	-.03
6.Nonsense							.58
7.Prose (verbatim)							

Table XV.

Intercorrelations Corrected for Attenuation with Probable Errors

	1.	2.	3.	4.	5.	6.	7.
1.Cancellation		.093±.11	.114±.11	.122±.11	.053±.11	.166±.11	-.031±.11
2.Speed of Manip.			-.0009±.11	-.19 ±.10	.104±.11	.104±.11	-.133±.11
3.Maze				.082±.11	.463±.08	.123±.11	.031±.11
4.Cup and Ball					.260±.10	.356±.10	.396±.10
5.Mirror						-.012±.11	-.032±.11
6.Nonsense							.604±.07
7.Prose (verbatim)							

Table XVI.

Correlations of Intelligence with Each of the Learning Problems, with Rank Standing on the Motor Problems*, with Rank Standing on the Verbal Problems*, and with Average Standing on All the Problems

	Intelligence (Henmon-Nelson Tests of Mental Ability-Form A)
1.Cancellation	-.12±.12
2.Speed of Manipulation	-.10±.12
3.Maze	.26±.11
4.Cup and Ball	.05±.12
5.Mirror	.02±.12
6.Nonsense	.27±.11
7.Prose	.55±.08
8.Rank Standing on Motor Problems	.02±.12
9.Rank Standing on Verbal Problems	.415±.10
10.Standing on all Problems	.25±.11

*See columns 5, 7, and 9 of Table XIII.

CHAPTER IV

DISCUSSION OF RESULTS

CHAPTER IV

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Discussion of Table XV. It can be noted from Table XV that the correlations between motor problems are relatively low or negative. It is an interesting fact that the maze test correlates with the mirror-drawing test to the extent of .46. This may be taken as an indication that the two problems have some factor in common. It can be noted further that these two problems do not correlate highly with any of the other problems. There are low correlations within the motor tests as a group and between the motor tests and the verbal tests. The highest correlation found was between the two verbal tests: nonsense syllables and prose.

Comparison of Present Results with Other Studies. The correlations within the motor tests as a group are in agreement with the generally low correlations found by Hollingworth[1] and Carothers[2]. Although the purpose of the present study and the problems used were different from Seashore's purpose and battery of tests, the correlations within the motor problems tend to bear out his conclusion "that motor skills are highly specific".[3] The fact that the motor problems present generally

(1)Hollingworth,H.L., Correlation of Abilities as Affected by Practice.Journal of Educational Psychology 4.1913.pp.405-414.
(2)Garrett,H.E.,and Schneck,M.R.,Psychological Tests,Methods and Results.New York.Harper and Brothers.1925.p.47.
(3)Ibid.p.64.

low and negative correlations is an indication, in addition to motor learning being specific, that these tests may not be measuring true motor ability and are only "so-called" motor tests.

The motor results of this study are in agreement also with the results obtained by investigators on sub-human motor learning ability, which were reviewed in Chapter I. While there is evidence among the various studies for the existance of a general maze learning ability, there is evidence for specific learning when all the problems are considered.

Of the investigators on both motor and verbal problems, Pyle[1] is the only one who draws conclusions different from the conclusions of other investigators whose studies have been reviewed in the literature and different from the results of the present study. This difference may be explained on the ground that Pyle did not observe certain techniques of experimental procedure and treatment of results which are used today.*

Garrett's correlations for his learning problems ranged from .09 to .57 (Table VI). This table of intercorrelations does not present evidence in support of a general learning ability. Gundlach's study (Table VI) does not show that correlations rise with practice "due to a more accurate tapping of ultimate capacity or general ability".[2]

Hall found a correlation of .11 between nonsense syl-

(1) Pyle, W.H., The Psychology of Learning. Baltimore. Warwick & York. 1928. p.222.

(2) Gundlach, Ralph, The Effects of Practice on the Correlations of Three Mental Tests. Journal of Educational Psychology 17. 1926. p.395.

* See Chapter I.

lables and a stylus maze, and .84 between the punchboard maze and nonsense syllables (Table VIII). The present study shows a correlation of .126 (corrected) between the maze and nonsense syllables. The results of the present study considering both motor and verbal intercorrelations tedn to point to agreement with Hall's results.

The results of this study are in harmony with the results of Shelburne's study (Table IX). Shelburne found a correlation of -.03 (not corrected) between nonsense syllables and the maze, and a correlation of -.16 (not corrected) between the maze and poetry. The present study shows a correlation of .126 (corrected) between the maze and nonsense syllables, and a correlation of .031 (corrected) between the maze and prose. Shelburne found correlations ranging from -.16 to .69 for the six problems, one of which was a pure motor problem--the maze. He concluded that there is no evidence shown by his study that there is a general factor running through all learning. However, he pointed out that there is evidence for a group factor in the learning of the nonsense syllables, poetry, and the Hawaiian vocabulary. Table IX shows a correlation of .59 between nonsense syllables and poetry; .63 between vocabulary and poetry, and .70 between vocabulary and nonsense syllables. These are the highest group correlations that were found. The present study shows a correlation of .604±.07 between nonsense syllables and prose (verbatim). It is

significant that these high correlations were found under two different experimental situations, one concerned with college students and the other with high school students. The fact that both studies find high correlations between some of the learning problems of a verbal nature might suggest a possible group factor with respect to these specific learning situations.

Anastasi[1], in her study on immediate memory, thought that the results pointed to a general factor; however, in her second study[2] she obtained results which agree with most of the results on motor and verbal learning.

Dr. Henneman has obtained consistently the highest correlations thus far on verbal learning. The correlations which he found ranged from .65 to .72 on the following problems: nonsense syllables, group of meaningful words, Malayan vocabulary, prose (ideas), and prose (verbatim). The results obtained in the present study agree favorably with the results of the above study. The fact that the present study is the third of three successive studies to find high correlations between certain groups of verbal tests is significant and tends to establish the existence of a verbal group factor. Henneman's results show that there is a general verbal ability so far as his study goes. Not enough verbal problems were included in the present study to

(1) Anastasi, Anne, A Group Factor in Immediate Memory. Archives of Psychology, Number 120. 1930. pp.1-61.
(2) Anastasi, Anne, Further Studies on the Memory Factor. Archives of Psychology, Number 142. 1932. pp.1-60.

indicate further how great the range of the verbal factor is.

The literature reveals that only a few investigators have worked out correlations between intelligence and specific motor problems. A few correlations have been obtained only between mirror-drawing and intelligence and the maze and intelligence. Table XVII shows the results.

Table XVII.

Intelligence Correlated with Mirror-Drawing and the Maze

Investigators	Intelligence with Mirror	Intelligence with Maze	Subjects
1.Burt(1)	.67		50 elementary school boys
2.Calfee(2)	.07 (Note)		Group of elementary school boys
3.Spence and Townsend(3)		-.09 to .52	Two groups of college students
4.Clinton(4)	-.58 to.27		Elementary, high school and college
5.Shelburne(5)		-.255	28 college students
6. The Present Study	.02	.26	55 high school students

(Note) This correlation is with school grades

(1) Garrett, H.E., and Schneck, M.R., Psychological Tests, Methods, and Results. New York. Harper and Brothers, 1933. p.103.
(2) Calfee, M., College Freshman and Four General Intelligence Tests. Journal of Educational Psychology 4.1913. p.227.
(3) Garrett, H.E., and Schneck, M.R., Psychological Tests, Methods, and Results. New York. Harper and Brothers. 1933. p.58.
(4) Clinton, R.J., Nature of Mirror-Drawing Ability: Norms on Mirror-Drawing for White Children by Age and Sex. Journal of Educational Psychology 21.1930. p.12.
(5) Shelburne, T.P., A Preliminary Study in General Learning Ability. Unpublished Master's Thesis, College of William and Mary. 1937. p.55.

It will be noted that there is a high degree of agreement between the correlations of intelligence with the mirror-drawing test except in the case of Burt's correlation of .67. The correlation of the present study of .02 would tend to point evidence toward Clinton's conclusion that "there is no positive relationship between mirror-drawing ability and general intelligence."(1)

There is some disagreement between the correlation of intelligence with the maze score. Since the correlations range from a minus quantity to a positive quantity, it cannot be said that the maze ability is highly related to intelligence. The present study shows a correlation of .26 between maze ability and intelligence.

It will be observed from Table XVI that the motor problems do not correlate highly with intelligence. The correlation with the rank standing on the motor problems is only .02±.12. The two verbal problems correlate higher with intelligence than any of the motor problems. The highest correlation obtained is .55. .08 between the prose test and intelligence. This shows that the verbal problems individually and collectively correlate more highly with intelligence than any of the motor tests. The fact that there is a low correlation between the

(1) Clinton, K.J., Nature of Mirror-Drawing Ability: Norms on Mirror-Drawing for White Children by Age and Sex. Journal of Educational Psychology 21. 1930. p.228.

motor tests and intelligence brings the correlation down to .25 when intelligence is correlated with the rank standing on all problems.

Evidence for a General Learning Ability. Due to the large number of low and negative correlations, the present study cannot give any evidence in support of a general learning ability. Although there is a high correlation between the two verbal tests, it cannot be concluded from this study that there is a general verbal learning ability.

Evidence for a Group Factor. Table XV suggests that a group factor is present in the learning of the maze and the mirror-drawing tests. This is indicated by the fact that there is a fairly high correlation between these two tests and further, by the fact that these two tests do not correlate significantly with any other test. The high correlation between the verbal tests point to the presence of a group factor.

Evidence for Specific Learning Abilities. This study points to the fact that motor learning is specific and also that motor learning does not correlate highly with verbal learning. It would add evidence to Seashore's[1] conclusion that motor skills are specific.

(1) Garrett, H. E., and Schneck, M.R., Psychological Tests, Methods, and Results. New York. Harper and Brothers. 1933. p.54.

CHAPTER V

CONCLUSIONS

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The results of the present study, in which high school pupils were used in learning situations, suggest the following conclusions:

1. Motor learning is specific and does not correlate highly with either the verbal problems or intelligence.
2. Table XV suggest that the same type of learning is present in the maze and mirror-drawing problems.
3. There is a group factor present in the learning of the verbal problems.
4. There is a higher correlation between verbal tests and intelligence than between motor tests and intelligence.
5. The results of this study agree in general with those of other studies of a similar nature.

APPENDIX

APPENDIX

Administration, directions, and further descriptions of each problem are included in this section.

Cancellation. As was stated above, a preliminary cancellation test was given to each subject ten times, and time and errors were recorded. All preliminary motor work was given six weeks before the tests (included in this thesis) were started. The fact that all the motor tests were given individually (except the cancellation test which was given in groups of four) explains why the adjustment set period was rather extended. Each subject was provided with pencils and from twenty to thirty mimeographed copies of the cancellation test. Twenty seconds rest period was given between each trial. The directions were as follows:

"All of you please listen carefully to the directions. The test which you are about to perform is a cancellation test, similar to the first preliminary test which each of you has taken. The object is to cancel all the a's and i's as rapidly as possible. To cancel an a or an i, simply mark through it once. Time is the important element, but be careful about errors. You will be penalized one second for each error not corrected and for every a or i not cancelled. To correct an error, simply make one mark in the opposite direction over the error. Raise your pencil the instant you finish the paragraph, and turn your copy face down. Are there any questions? Turn your copy over. Go!"

A Sample Copy of the Cancellation Test

"Since the necessary reactions to environment begin at birth or even before, it is proper to speak of possibilities of certain kinds of behavior or tendencies to action, meaning simply that the first time a stimulus affects the organism a particular response will follow. How are these original tendencies to action modified as a result of environmental influences, or, to put the case more simply, how does one learn?"

Speed of Manipulation. Each subject was provided with a board of thirty-six holes (black, white, green, and red) and thirty-six stoppers (nine of each color). A thirty second rest period was given between each trial. The directions were as follows:

"When the board is turned over, you find that it is similar to the preliminary board; however, this board has four colors (in a certain order) instead of three. You may now turn the board over. Your objective is to place a colored stopper in the proper hole as rapidly as possible with one hand until each hole is filled. Start on the left and go to the right on the row nearest you. As you finish a row, always start on the left-hand side of the next row. Fill in each hole in succession; do not omit any. Since there are only thirty-six stoppers, you must correct any error as you proceed with the test. Are there any questions? Ready, go!"

Figure I

A Pattern of the Speed of Manipulation Board

G	R	B	W	G	R
B	W	G	R	B	W
G	R	B	W	G	R
R	W	G	R	B	W
G	R	B	W	G	R
B	W	G	R	B	W

The letters represent the holes. B, black; W, white; G, green; R, red.

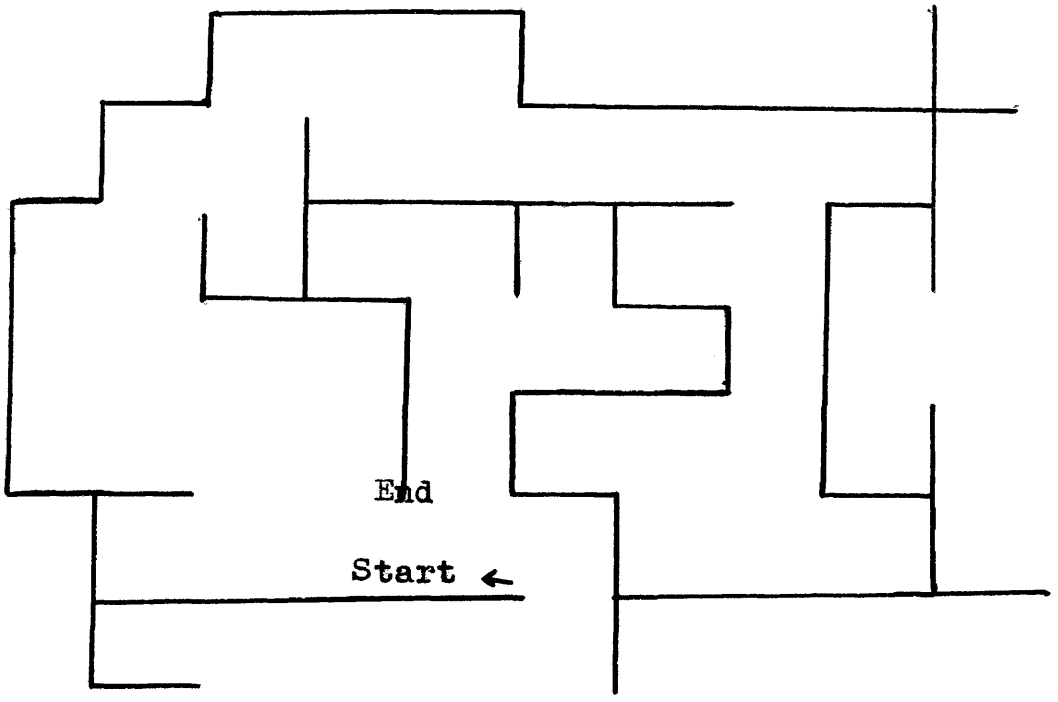
The Maze. The subjects were not allowed to see the test either before starting or between trials. Each subject was given approximately thirty seconds to rest between trials. The directions were:

"This maze pattern is different from Maze A, yet no more difficult. You must trace with only one finger of your writing hand the correct passage way. Learn to do this as rapidly as possible twice in succession without any errors. Do not move your fingers from the board until you are directed to do so. Are there any questions? Ready? Go!"

A pattern of the maze problem is found on the following page.

Figure 2

A Sample Pattern of Maze B



The Cup and Ball. The cup and ball test consists of a cup on the end of a six inch handle with a ball attached to the lower end of the handle by a twelve inch string. Several demonstrations were given each subject before the test began. A rest period of twenty seconds was given between each trial. The directions were as follows:

"Please listen carefully. This is a new test; one on which you have not had any practice. Your objective in this test is to catch the ball in the cup ten times in succession as soon as possible. You must do this on two trials in succession. In other words, a trial consists of the number of throws that are necessary to catch the ball ten times. Your purpose is to catch it ten times straight on two trials in succession. Work with as great speed as you can. Count aloud your correct throws, or each time that you are successful in catching the ball. Are there any questions? Ready? Go!"

Mirror-Drawing. This was also a test on which the subjects had not received any preliminary practice. Each subject was provided with a pencil, the necessary number of double stars, the drawing box and a mirror. The following directions were given:

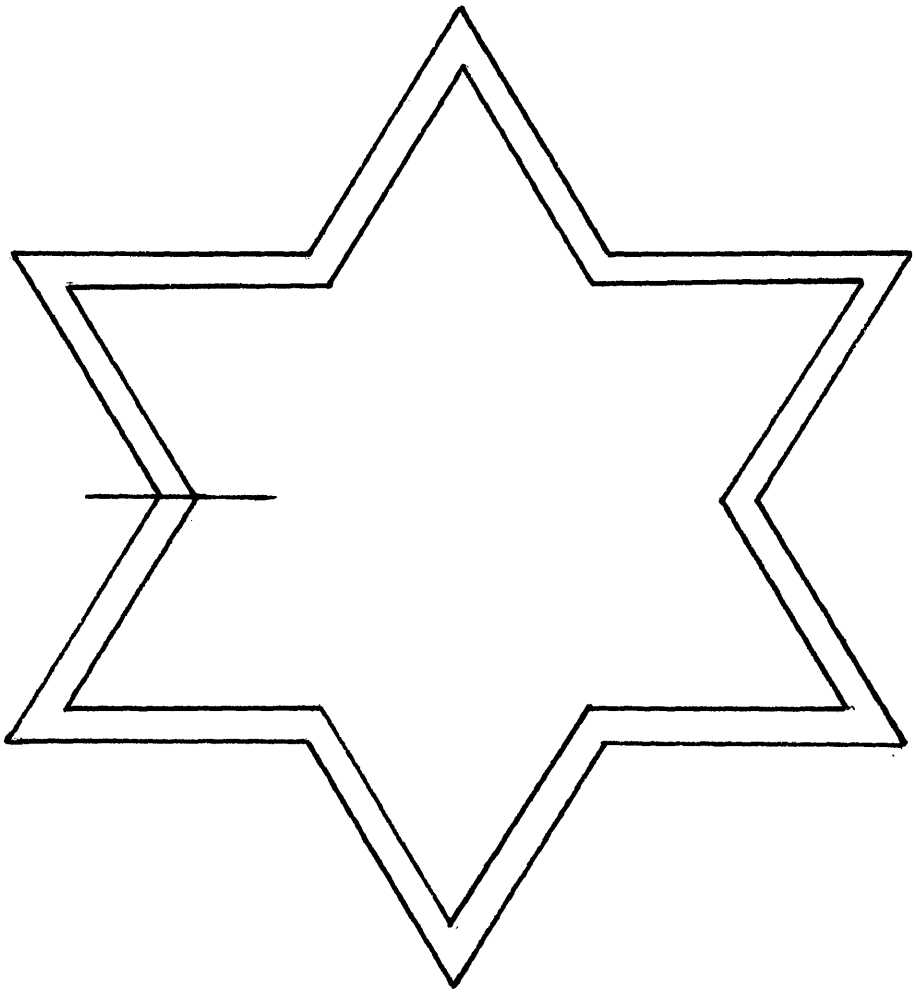
"This is called the mirror-drawing problem. You are to draw a third star within the borders of the double star. This must be done without errors while looking in the mirror. Start on the horizontal line. Do not lose time by see-sawing about in any one place; go in some direction even though it may be wrong. Do not lift

your pencil from the board until you have finished the star. If you touch either the outside or the inside outline of the double star, it is counded as an error. You want to perform at least once without an error as rapidly as you can. Do not grow impatient with the errors on the first few trials. Work hard until you have mastered the problem. Are there any questions? Ready? Go!"

A sample star is given on the following page.

Figure 5

A Sample Double Star

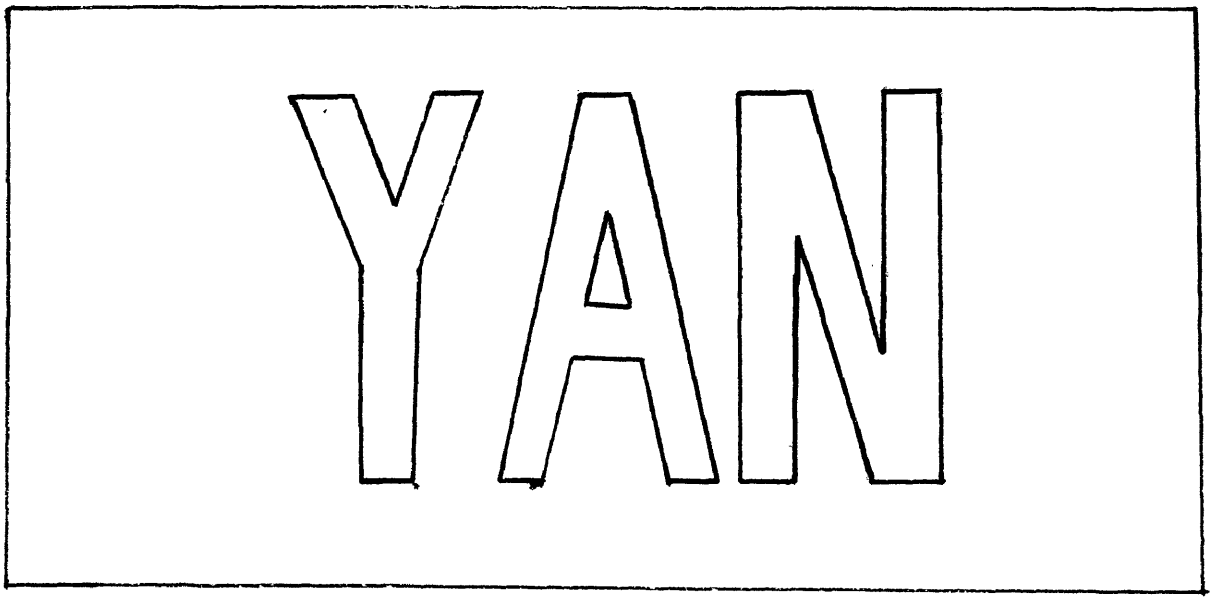


Nonsense Syllables. Each subject was given a data sheet and pencil. The administrator used a metronome in exposing the ten syllables serially, two seconds for each syllable. After the ten had been exposed, the subject was required to write as many as he or she could think of in twenty seconds. The writing time was increased on the sixth trial to thirty seconds and to thirty-five seconds on the eleventh trial. It was necessary to increase the writing time on certain trials because as the subjects progressed with the test more time was needed in writing the syllables. This test and the prose test were given to about one-half the subjects at once. The nonsense syllables used were: yan, koj, hes, tib, seg, vid, nad, jus, fab, raz. Each syllable was printed on a card three by six inches. On the following page is given a sample of one of the syllables. The directions were as follows:

"In this nonsense syllable test you have ten syllables to learn perfectly instead of six as you had on the preliminary. Each syllable will be exposed for two seconds on each trial in the same order until you have mastered them. Do not start writing until I have exposed the tenth syllable and you have the sign to begin. Are there any questions? Do your very best. Try to surpass your standing on former tests. Ready? Go!"

Figure 4

A Sample of the Nonsense Syllables



Data Sheet for Nonsense Syllables

Name._____

Trial 1.	Trial 2.	Trial 3.	Trial 4.	Trial 5.
1.	1.	1.	1.	1.
2.	2.	2.	2.	2.
3.	3.	3.	3.	3.
4.	4.	4.	4.	4.
5.	5.	5.	5.	5.
6.	6.	6.	6.	6.
7.	7.	7.	7.	7.
8.	8.	8.	8.	8.
9.	9.	9.	9.	9.
10.	10.	10.	10.	10.

Trial 6.	Trial 7.	Trial 8.	Trial 9.	Trial 10.
1.	1.	1.	1.	1.
2.	2.	2.	2.	2.
3.	3.	3.	3.	3.
4.	4.	4.	4.	4.
5.	5.	5.	5.	5.
6.	6.	6.	6.	6.
7.	7.	7.	7.	7.
8.	8.	8.	8.	8.
9.	9.	9.	9.	9.
10.	10.	10.	10.	10.

Prose. Each subject was given blank sheets and a penoil. The administrater read a fifty work selection from Wirth's The Development of America. About twenty seconds were used each time in the reading of the selection. The subjects had to learn the selection verbatim without seeing it. The writing time was increased gradually from thirty seconds on the first trial to one hundred and twenty seconds on the fourteenth trial and remained constant for any trial beyond the fourteenth. Thus the total learning time on any trial was the reading time plus the writing time; e.g., on the first trial the total learning time was fifty seconds(twenty seconds for reading and thirty seconds for reproducing). A copy of the selection is given below. The directions were:

This is the last test on which we will work for the present experimental learning situation. Each of you has done well from the standpoint of inter st as well as performance. Try to make this your best performance. I will read to you a selection of fifty words from The Development of America, by Wirth, until you have learned it perfectly. Do not begin writing until I have finished reading each time. You must stop writing immediately when told to do so. Are there any questions? Do your very best. Ready? Go! "

A Copy of the Prose Selection from
The Development of America by Wirth

"The responsibility of the schools to give a complete education to the young people is constantly increasing. Within recent years many parents, because of social and industrial changes, have not been able or willing to offer as much training at home as was given years ago in the old-type home".

SCORE SHEET

Name _____ Test _____

Trial	Time	Errors	Remarks
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			
19.			
20.			
21.			
22.			
23.			
24.			
25.			
Total			

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VITA

VITA

Name - Woodrow W. Wilkerson

Date of Birth - April 29, 1915

Place of Birth - Prospect, Virginia

Home - Dillwyn, Virginia

Academic Career - Graduate - Prospect High School, 1930
Prospect, Virginia

Graduate - Hampden-Sydney College, A.B. 1934

Applicant for degree of Master of Arts, College of William and Mary, 1938

Positions Held - Teacher, Victoria High School
Lunenburg County, Virginia
1934-35;1936-1936

Principal, Dillwyn High School
Buckingham County, Virginia
1936-1937; 1937-1938