A Test Construction Study of Sport-Type Motor Educability for College Men.

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A TEST CONSTRUCTION STUDY OF SPORT-TYPE
MOTOR EDUCABILITY FOR COLLEGE MEN

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in
The Department of Health and Physical Education

by

Arthur R. Adams
B.S., Louisiana State University, 1949
M.S., Louisiana State University, 1950
June, 1954
MANUSCRIPT THESES

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ABSTRACT

Motor educability is the quickness with which motor skills are learned. The three tests generally purported to measure motor educability are the Brace test, the Iowa-Brace test, and the Johnson test.

Previous researches warrant the following generalizations:

1. Actually there are two types of motor educability—stunt-type and sport-type.

2. Stunt-type motor educability is not highly related to sport-type motor educability.

3. The Johnson test is the most valid of the above-mentioned tests as a measure of stunt-type motor educability, although all three are satisfactory for this purpose.

4. None of the above-mentioned tests are valid as a measure of sport-type motor educability.

The primary purpose of this study was to select the battery of tests from an experimental group of 49 tests that would maximally predict sport-type motor educability for male college freshmen.

The criterion was a composite score on four sport-type learning tests. These tests are a revision of learning tests that have been used repeatedly at the University of Texas as the criterion of motor educability.

The experimental battery consisted of 49 tests. All the tests in the Brace battery and the Iowa-Brace battery, selected tests...
from the Johnson battery, two agility tests, the 50 yard dash, thirteen

tests devised by this writer, and short practical forms of the learning
tests used in the criterion composed this battery.

Tests were screened for difficulty, reliability, and relation­ship to strength and/or power. Each test not discarded by this
screening process was intercorrelated with every other test and with
the criterion. The Wherry-Doolittle Test Selection Method was used to
select the smallest number of tests which would maximally predict the
criterion.

Four tests were selected by the Wherry-Doolittle Method as the
battery which had the highest validity of any combination of tests in
the experimental battery. The multiple correlation between the
criterion and these four tests was $R_{.7897} (R_{.7897})$.

Test 1 is a Wall Volley Test. The subject stands three feet
from a wall and volleys a volleyball above a line drawn on the wall ten
and one-half feet above the floor. The score on each trial is the
number of consecutive volleys up to ten. The total score is the sum
of the scores made on seven trials.

Test 2 is called Lie on Back, Throw Tennis Ball in Air, and
Catch. The subject lies flat on his back, holding a tennis ball. He
throws the ball six feet or higher in the air and catches it in either
hand while remaining in the "lying on back" position. The total score
is the number of successful attempts in ten trials.

Test 3 is a Ball Bounce Test. The subject stands in the middle
of a six foot circle and attempts to volley a volleyball on the top
end of a bat. The number of consecutive bounces up to ten is recorded

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on each of ten trials. The total score is the sum of the scores made on the ten trials.

Test 4 is a Basketball Shooting Test. The subject takes twenty shots from the free throw line. The score is the number of successful attempts in the twenty trials.

The regression equation for predicting the criterion in raw score form is:

\[ \bar{Y}_c = 7.174X_1 + 17.2857X_2 + 2.7014X_3 + 19.2265X_4 \]

Two reliability estimates of the selected battery yield correlation coefficients of .9136 and .8882. Apparently the reliability of the selected battery is satisfactory.
CHAPTER I

THE PROBLEM

I. INTRODUCTION

Since the term "Motor Educability" first appeared in the literature by McCloy\(^1\) in 1934, it has become one of the more discussed phenomena in the field. Motor educability has been defined or referred to as motor learning,\(^2\) speed of learning gross bodily skills,\(^3\) "ability to learn new skills,"\(^4\) and "the ability to develop high skill quickly."\(^5\)

The amount of writing on the subject has undoubtedly been prompted by the dire need of such a measure in the field of physical education.

Need. Brace states that a measure of motor educability would make it possible to distinguish slow learners from fast learners, and


therefore enable one to classify students into groups on the basis of their ability to learn motor skills.

Gire and Espenshade\(^7\) state that a measure of motor educability "would contribute to a better understanding of physical performance and would provide an effective tool for the administration of the physical education program."

A valid measure of motor educability could be used to screen students desirous of becoming majors in physical education. Some physical educators believe that a major in the field of physical education should possess no less than average ability "to learn new motor skills quickly." With a valid measure of motor educability, standard scores could be obtained over a few years which would make such screening possible.

A valid measure of motor educability could contribute to the most essential tasks of evaluating teaching and pupil growth. If a student's achievements do not approach his capacity, some obstacle is obviously hindering his growth. Thus a motor educability test would be a useful prerequisite to the ever important task of locating and obviating problems hindering pupil growth.

Such a measure would be of value in equating groups for experimental studies. At the onset of an experimental study a


researcher could equate groups in terms of both present developed ability and educability.

Finally, a valid measure of motor educability would be of value as the criterion for future test construction and validation studies of motor educability.

II. POSSIBLE APPROACHES TO TEST CONSTRUCTION STUDIES

Recent studies indicate rather conclusively that there are at least two types of motor learning—that of the sport-type and that of the stunt-type—and that these two types are not highly related. Thus in a test construction study of motor educability it appears that the researcher has four possible alternatives in his approach to the problem:

1. He might attempt to construct a valid measure of the general phenomenon of motor educability. Since we are fairly certain that there are at least two types of motor learning and that these two types are not highly related, it would appear to the present writer to be very difficult, if not impossible, to select a practical battery of tests which would be highly related to a composite criterion composed of tests of both types of learning which are themselves fundamentally different. This alternative was therefore discarded.

---


2. He might attempt to construct a valid measure of motor educability for both types of learning, treating each type separately. Following this approach the researcher would have a criterion score for each type of motor learning, and he would select the most practical, valid battery for each type. The final battery of motor educability would be composed of the two smaller batteries—one to predict motor learning as it pertains to the sport-type and one as it pertains to the stunt-type of motor learning. The contributions of such a study are unquestionable, but the immensity of such a problem makes it impractical for one study. This writer believes that there really exist two problems which should be treated in separate studies.

3. The investigator might attempt to construct a valid measure of motor educability as it pertains to the stunt-type learning. This appears to be the simplest alternative since existing tests purported to measure motor educability are of the stunt-type. It is conceivable that an extremely valid, reliable, and practical measure of stunt-type motor educability could be selected from tests within these batteries. However, by the same token, this would appear to be the lesser contribution.

4. Finally, the researcher might attempt to construct a valid measure of motor educability as it pertains to the sport-type learning. Since there is no sport-type motor educability test and since present batteries do not attempt to measure factors such as arm control, timing, and the hand-eye or hand-eye-foot coordination involved in hitting, kicking, throwing and catching, which are essential in the sport-type learning, it appears that a valid measure of motor educability
of the sport-type learning would be a greater contribution than that of the stunt-type. This is the approach selected by this writer for this study.

III. STATEMENT OF THE PROBLEM

It was the purpose of this study (1) to select the battery of tests from an experimental group of 49 tests that would maximally predict sport-type motor educability for male college freshmen, (2) to set up standard scores for the selected battery based on the subjects in this study in the event that a valid battery is constructed, and (3) to determine the validity of the Brace Test and the Iowa Revision of the Brace Test for Senior High School boys as measures of sport-type motor educability for male college freshmen.

IV. DEFINITIONS OF TERMS USED

Motor Educability. Motor Educability as referred to in this study is the quickness with which motor skills are learned.

Sport-Type Learning. Sport-Type Learning refers to learning peculiar to activities in which the participants must strike, throw, catch, or in some way manipulate a ball or some external object. Such activities are tennis, baseball, basketball, handball, volleyball, golf, and badminton.

Stunt-Type Learning. Stunt-Type Learning refers to the learning peculiar to those activities involving control, coordination, and
dexterity in gross bodily movements, but not involving manipulation of an external object. This type of motor learning is exemplified in tumbling.
CHAPTER II

REVIEW OF THE LITERATURE

I. FACTORS IN MOTOR LEARNING AND MOTOR ABILITY

Gross Motor Skills. In 1929 Cosens attempted to determine the factors considered most important in general athletic ability. On the basis of the judgment of fifty-two physical educators, the seven elements considered most important were located. These seven elements of general athletic ability are:

1. Arm and shoulder-girdle strength.
2. Jumping strength, leg strength, and leg flexibility.
3. Arm and shoulder-girdle coordination.
5. Body coordination, agility, and control.
7. Speed of legs.

In 1933 Jones reported that chinning strength, power (Sargent Jump) and the Brace test were not highly related. The fact that each test measures something not measured by the other two (he concludes) establishes another reason for believing that this battery of tests is valid for determining several aspects of motor capacity.

In 1940 McGloy\textsuperscript{3} reported a study of the factors in motor educability. Concerning the study, the author says:

Not all of them (the factors) are uncorrelated with each other. Some are probably intercorrelated, and some of these are probably partially synonymous with slightly different factors found in other studies of the same abilities. Since they are from different studies, however, and in these different researches seem to show slightly different characteristics, we have listed them for the sake of completeness, hoping that further studies of the specific items will determine their relatedness or independence.\textsuperscript{4}

1. Insight into the nature of the skill.
2. Ability to visualize spatial relationships.
3. The ability to make quick and adaptive decisions.
4. Sensory motor coordination I. This type of coordination is related to catching, striking, or kicking of balls.
5. Sensory motor coordination II. "This type of sensory motor coordination is the adaptation to weight and force."\textsuperscript{5}
7. Accuracy of direction and small angle of error.
8. General kinesthetic sensitivity and control.
9. Ability to coordinate a complex unitary movement.
10. Ability to coordinate a complex series or combination of movements which follow one another in rapid succession.
11. Arm control.
15. Sensory rhythm.

The same year (1940) Gates \textsuperscript{6} and Sheffield reported that the ability to change direction is an important factor in determining

\begin{flushright}
\textsuperscript{4} Ibid., pp. 32-33.
\textsuperscript{5} Ibid., p. 33.
\end{flushright}
motor skill among junior high school boys. The measures of motor ability used in this study were the Johnson Test, the Iowa-Brace Test, and the Burpee Test.

In 1943 Carpenter\(^7\) reported a factor analysis of motor educability. She used ten items of the Johnson Battery and eight other items similar to Johnson type tests. The study located three factors of motor educability. They are:

1. Bodily control in turns about a lateral axis—probably closely related to the functioning of the semi-circular canal.
2. Ability to solve new motor skill coordination problems quickly or true motor educability.
3. Factor III is not named.

In 1946 McCraw\(^8\) reported a factor analysis of motor learning. His matrix consisted of thirty variables. Sport-type tests, stunt-type tests, age, weight and tests of many other variables were represented. The author located eight rather distinct factors of motor learning. They are:

1. Body size.
2. Athletic ability.
3. Motor ability. This test is so named because its highest loading is on the Brace Motor Ability Test. Tests involving stunt-type activities had heavy loadings with this factor.
5. Dynamic object control without implement in sport-type motor learning.
7. Dynamic object control with implement in sport-type learning.


6. Aiming control in static body position in sport-type motor learning.

**Fine Motor Skills.** This study concerns itself with gross motor skills and at least one researcher reports no relationships between fine and gross motor abilities. However, some factor studies of fine motor skills are briefly reported here for whatever interest they may be to the reader.

In 1938 Buxton reported a factorial study of motor ability. He identified three factors:

1. Manipulative performance.
2. Steadiness.
3. A speed or relaxation factor.

That same year (1938) Seashore and Buxton reported another factorial study. Using twenty-one tests of fine motor abilities, the authors tentatively identified the following factors:

1. Repetitive forearm speed, e.g. tapping.
2. Not named.
3. Single forearm-hand reaction times, visual and auditory.
4. Repetitive finger-hand speed.
5. Steadiness.
6. Forearm and hand manipulations in tasks necessitating perception of spatial relations.

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Two years later (1940) Seashore, Buxton, and McCollom\(^{12}\) again reported a factorial analysis of fine motor skills. The writers first tested for a common general factor. Finding that there was none, the writers completed the factor analysis and reported six factors in fine motor skills. As listed by the writers, they are:

1. Speed of a single reaction.
2. Finger, hand, and forearm speed in restricted oscillatory movements.
3. Forearm and hand speed in oscillatory movements of moderate extent.
4. Steadiness.
5. Skill in manipulating spatial relations.
6. A residual for the battery of tests.

II. TEST CONSTRUCTION STUDIES

The first of the motor educability tests was published by Brace in 1927.\(^{13}\) The test was labeled a "motor ability" test by Brace and was purported to measure natural or native motor ability rather than acquired motor ability. Thirty tests were chosen in a preliminary experiment. Ten of these were ultimately discarded and the final battery consisted of twenty stunt-type tests. Three criteria were used to validate this final battery. They are (a) judgment ratings, (b) scores on a variety of athletic events, and (c) achievement in athletic games. The final battery correlated .58 with the judgment ratings and .73 with the sum total of a variety of athletic events.


Students on athletic teams had consistently higher Motor Ability Test scores than students in general. Brace recommended these tests for boys and girls, men and women.

In 1932 Johnson\(^1\) presented a test for sectioning students into homogeneous groups. He stated that this test is an attempt to test native neuro-muscular skill capacity.\(^2\) Out of an experimental battery of one hundred exercises, ten were selected for the final battery. (Johnson did not state on what basis the final ten were chosen.) He reports that the exercises do not test strength, speed, or endurance which he felt are products of experience. A validity coefficient of .69 and a reliability coefficient of .97 are reported for the battery. (He does not state the method of determining the reliability, the criterion upon which the validity coefficient is based, or the age or sex of his subjects.) He recommends the test for both sexes and ages ranging from 11 to 38 years.

In 1935 Hill\(^3\) reported a test construction study of motor educability. His subjects were eighth grade Negro boys in the Northeast Junior High School in Kansas City, Kansas. His criterion was the composite score on the rate of learning ten tumbling stunts. Fifty-five stunt-type tests composed his experimental battery. Hill

\(^2\) Ibid., p. 128.
reported a correlation of .624 between a battery of twelve tests and the criterion. The reliability coefficient reported for the battery as stepped up by the Spearman-Brown formula was .785.

This writer was able to find only one other mention of Hill's test in the literature. This was by Hatlestad who administered the Brace test, the Iowa-Brace test, the Hill test, and the Johnson test to 130 college women. Her purpose was to provide a comparative scheme for physical educators wishing to use one or another of the educability tests in the computation of general motor capacity. She found intercorrelations to be high enough between the Brace, Iowa-Brace, and Hill tests to justify using T-scores of the Brace test or the Hill test instead of the Iowa-Brace in the computation of general motor capacity. Correlations between these tests and the Johnson test were not as high and there was a question as to the reliability of the Johnson test. She pointed out further that there is a greater need for objectivity in the scoring of this test.

The next test construction study of motor educability to be reported was by McCloy in 1937. He felt that it might be possible to use the stunt-type of test to measure motor educability or ability to learn new skills in a somewhat more limited way than had been

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planned by Brace. A preliminary study was first conducted with 42 junior and senior high school boys. Thirty-nine stunts were selected from various stunt books—all the stunts used by Brace were included. The total number of the 39 stunts passed successfully on the first trial was used as the criterion score. The success or failure to execute each stunt on the first trial was correlated against this criterion by bi-serial correlation. From these 39 stunts the 24 tests with the highest correlations were considered for further study.

Next, data were gathered for these 24 tests on 335 boys and 424 girls from the Des Moines public schools. Each of the 21 tests that were retained met the following criteria:

1. The percentage of people passing it increased consistently with age.
2. Each had a relatively low correlation with Strength, with the Classification Index, and with the Sargent Jump.
3. Each correlated rather highly with track and field athletic ability.

From the 21 tests, McCloy formulated six batteries, three for each sex at varying age levels. "The final selection of the test batteries for each age group was largely subjective."20

Wendler21 reported (1938) that a combination of the Johnson test, Burpee test, and the Brace test ideally weighted correlates quite high with a motor educability factor.

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19 Ibid., p. 46.
20 Ibid., p. 49.
In 1940 Carpenter\(^2\) reported a test construction study of motor educability for children of the first three grades. Twelve tests similar in kind to the Johnson test composed her experimental battery. Her subjects were 128 boys and 125 girls from the first three grades.

First the reliability of the twelve tests was determined and four of the tests were discarded for lack of reliability.

Next the remaining eight tests combined with other tests were intercorrelated and a factor analysis was accomplished. The Johnson type tests stood apart from the other tests analyzed and Carpenter concluded that these tests represent a different factor, which is motor educability.

Tests were then discarded for both sexes which seemed only to duplicate other tests. Finally a battery of five tests was recommended for both sexes with a separate regression equation for each sex. Norms were then determined for ages six through nine for both sexes.

III. STUDIES TESTING THE VALIDITY OF VARIOUS TESTS OF MOTOR EDUCABILITY

In 1933 Johanssen\(^2\) reported the Brace test was the best single measure for the prediction of tumbling ability. (The Johnson


test and the Iowa-Brace test were probably not included in his study. The Iowa-Brace test was not published until 1937, and Johannsen's study was probably well under way when Johnson's test was published in 1932.) A combination of the Sargent jump, Brace test and the Burpee test was reported to be the best combination for this prediction. The author found McCloy's general motor capacity test to be of little value, if any, for predicting tumbling ability.

Hoskins (1934), working with college freshmen, reported very low correlations between learning in certain physical education activities and McCloy's general motor capacity and general motor ability tests. The activities studied were touch football, swimming, basketball, handball, boxing, tap dancing, and other individual activities. Subjective rating was the criterion of learning in the various activities.

Hander (1935) reported a study to determine the effects of some specific factors on the speed of learning certain motor skills. Speed of learning on certain learning tests was the criterion. She concerned herself with teachers' ratings and grades, an intelligence test, and an experience questionnaire. The following conclusions were drawn:

---


1. Individuals vary widely in their ability to learn gross bodily motor skills.
2. There seems to be no relationship between speed of learning motor skills and intelligence.
3. There appears to be little relationship between the teachers' ratings and the learning tests.
4. Age appears not to influence the ability to learn motor skills rapidly.
5. The ability to learn motor skills quickly varies for different skills. (One stunt-type test, one rhythm test, and three sport-type tests composed the learning tests used as the criterion. This statement may partially explain this conclusion.)
6. A variety of factors influence the ability to learn motor skills rapidly. (The comment made under "5" above may partially explain this conclusion.)

In 1936 Barton reported that the Johnson test was more valid than the Brace test as a measure of motor educability for junior high school girls. Her criterion of motor educability was the ability to learn a series of stunt-type tests.

Working with senior high school girls, Rhodes (also 1936) confirmed Barton's conclusion that the Johnson test was a more valid measure of motor educability than the Brace test.

Kirkner reported the relationship between rate of learning and measures of various physical abilities. Rate of learning was the

---

26 Gertrude Barton, "A Comparative Study of the Brace Type of Test and the Johnson Type of Test as Measures of Motor Educability in the Junior High School Girl" (Master's Thesis, State University of Iowa, 1936), cited by Kulcinski, op. cit., p. 98.

27 Hazel M. Rhodes, "A Comparative Study of the Brace Type of Test and the Johnson Type of Test as Measures of Motor Educability in the Senior High School Girl as Shown by Two Selected Criteria" (Master's Thesis, State University of Iowa, 1936), cited by Kulcinski, loc. cit.

average rate of learning on five learning tests (one stunt-type test, three sport-type tests, and one motor rhythm test). Low correlations (less than .2) were obtained for the Brace test, the Iowa-Brace, the Brace and the Iowa-Brace tests combined, and a strength test. A slightly higher correlation (.34) was found between the learning tests and McCloy's Athletic Index.

Kobb tested the hypothesis that the Johnson test can be used to predict motor educability (1937). His criterion was the ability to learn a group of tumbling stunts. His subjects were 100 boys chosen at random from the seventh, eighth, and ninth grades of the Jefferson Junior High School at Dubuque, Iowa. All subjects having previous tumbling experience were excluded from the study. Ages ranged from 11 to 16 years. A correlation coefficient of .9687 was found between the criterion and the Johnson test.

Studying the Johnson test further, Metheny (1938), working with junior high school boys, reported a multiple correlation of .934 between the criterion and tests 5 + 7 + 8 + 10 ($R_c.5, 7, 8, 10 = .934$). This was only slightly lower than the correlation of .966 for the whole battery. The criterion was the quickness with which ten tumbling stunts were learned.


30 Eleanor Metheny, "Studies of the Johnson Test as a Test of Motor Educability," Research Quarterly (9:105-114, December, 1938).
For junior high school girls she reported a multiple correlation of .868 between the criterion and tests 5 + 7 + 8 \( (r_{c.578} = .868) \).

In 1939 McNeely\(^{31}\) reported that neither the Brace test nor the Iowa-Brace test is highly related to the rate of learning swimming skills.

In 1941 Brace\(^{32}\) tested further the validity of the Brace test and the Iowa-Brace test as measures of rate of learning motor skills. Rate of learning was measured by an average of the rate of learning five learning tests (one stunt-type test, three sport-type tests, and one motor rhythm test). These scores were correlated against the Brace test and the Iowa-Brace test—all correlations were positive, but low.

Additional evidence of the lack of relationship between measures of sport-type motor learning and tests of physical abilities was presented by Dunlap\(^{33}\) in her study with high school girls (1942). Two criteria were used as measures of physical ability—the first consisted of the total score on three standardized tests—the Iowa-Brace, the Metheny-Johnson, and the Burpee tests; the second was the criterion of the first plus an athletic index composed of the standing broad jump,


\(^{33}\) Marie L. Dunlap, "Relationship between Motor Learning and Certain Tests of Physical Abilities" (Master's Thesis, University of Texas, 1942), cited by McCraw, op. cit., p. 64.
the running high jump, a softball throw for distance, and the 50-yard dash. The learning tests were modifications of those used by Hander and Kirkner (one stunt-type test, three sport-type tests, and one rhythm test). She reported that the tests of physical abilities do not indicate one's ability to learn motor skills.

Ehrlieh reported (also 1942) relationships between the learning of a motor skill and measures of strength, motor ability, motor educability, and motor capacity. Eighty-seven subjects were selected from students of the City College of New York. Data on each subject included McCloy's general motor capacity test, the Johnson test (his measure of motor educability), Larson's motor ability test, and Roger's strength test. An apparatus designed to measure speed and accuracy of the fencing lunge was constructed so that the learning process could be measured. The experiment lasted twelve weeks, with two weekly forty-five minute sessions utilized for instruction and practice, and a third period set aside for testing improvement in the lunge.

Ehrlieh concluded:

When improvement in the accuracy with which a fencing lunge is performed is used as a criterion of learning, the experimental evidence obtained in this study warrants the following conclusions:

(1) Individual differences in accurately coordinated body movements decrease with training and instruction.

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(2) Measures of strength, motor ability, motor educability, and motor capacity are not related to initial status on a learning curve, since the correlations between this segment and the four tests range from -.079 to .078.

(3) Measures of strength, motor ability, motor educability and motor capacity are not associated with rates of learning. The correlations obtained in this instance range in size from .073 to .195.

(4) Measures of strength, motor ability, motor educability and motor capacity show a significant relationship to maximum learning points, the Rogers' test correlating .423, the Larson test, .456, the Johnson test, .515, and the McCloy test, .672 with this segment of the learning curve.

(5) A multiple correlation coefficient of .674 was found between terminal end points on the accuracy learning curve and the four test batteries. This indicates that the McCloy motor capacity test provides as good an insight into the maximum learning potentials of individuals as does a combination of all four test batteries.

When improvement in the speed of bodily movement required for the performance of the fencing lunge is used as the criterion of learning, the evidence points to the following conclusions:

(1) A point in the learning curve is reached whereby the differentiation of individuals on the basis of speed is almost impossible. This point exists only after enough time has elapsed for the individual to adequately adjust and learn muscular patterns involved in the skill and when the distance through which the body moves is not more than thirty inches.

(3) Measures of strength, motor ability, motor educability and motor capacity show a marked relation to initial points on the speed learning curve. These correlations range in size from .352 for the Rogers test, .403 for the Larson test, .513 for the McCloy test, and .567 for the Johnson test.

(4) Measures of strength, motor ability, motor educability and motor capacity are not related to rates of learning. These correlations are insignificant and range in size from -.006 to .048.

(5) Measures of strength, motor ability, motor educability and motor capacity are not related to maximum learning peaks in speed since correlations of -.217 to .127 are commonly accepted as negligible.
(6) A multiple correlation coefficient of .590 was found between initial starting points and the four test batteries. This would indicate that the Johnson educability test alone provides as much information about initial starting points as does a combination of strength, motor ability, motor educability and motor capacity. It does not imply, however, that the Johnson test may be used as a highly reliable index of the initial portion of the learning curve.

When accuracy and speed are taken together as the learning process, an analysis of each one of the test batteries provides the following conclusions:

(1) McCloy's motor capacity test is a satisfactory diagnostic instrument for evaluating potential learning when both accuracy and speed of muscular movements are involved in a motor skill. A multiple correlation of .731 tends to support such statement, but this only applies to initial speed and maximum learning and does not refer to rates of learning.

(2) The Johnson motor educability test is less efficient than the McCloy test, in distinguishing individual differences in learning, but may be utilized for such purposes.

(3) Multiple correlation coefficients of .522 and .473 for the Larson and the Rogers tests with respect to both accuracy and speed, are so low as to eliminate them as possible diagnostic instruments for measuring individual differences in learning motor skills.

Gire and Espenschade reported a study (also 1942) of the relationship between measures purported to measure motor educability (The Brace test, the Iowa-Brace test and the Johnson test) and measures of achievement and learning of high school girls. Learning tests were devised in three specific sports—Basketball, Volleyball, and Baseball (all sport-type activities). The highest correlations with the learning score were with the Brace test, the Iowa-Brace test, and the Johnson

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test in that order; however, the degree of relationship in all cases was too low to warrant using any of these tests to predict ability to learn motor skills. The highest correlations reported were for the Brace test and the Iowa-Brace test with final achievement. Relationships between the Brace test, the Iowa-Brace test, and grades were reported by Espenshade in 1945. Her subjects were college women. Correlations between both batteries and grades in dance and tumbling ranged from .5 to .58 with no significant difference between the batteries. Correlations between these batteries and sport-type activities ranged from -.07 to .15.

In 1945 Burch reported that none of McCloy's measures (motor educability, motor capacity, and motor quotient) correlates highly with one's ability to learn motor skills. She used six learning tests as her criterion of motor learning. Four of the learning tests were sport-type tests, one was a stunt-type test, and one was a rhythm test. Neither motor educability, motor capacity, nor motor quotient correlated highly with any of the learning tests.

In 1946 commenting on Burch's study, Brace felt that the following conclusions were warranted:

(1) There are marked individual differences in ability to learn gross bodily motor skills.

37 Anna Espenshade, "Practice Effects in the Stunt Type Test," Research Quarterly (17:34-42, 1945).


(2) The learning of "sport type" skills involves somewhat different abilities from those required to learn to manipulate the body in stunt-type or rhythm-type coordinations.

(3) Ability to learn "sport type" motor skills is related rather closely to athletic ability and to speed, strength, agility, and power, and very little to ability to learn stunt-type skills.

(4) The Brace motor-ability test does not measure motor learning to an extent that would justify the test being classified as a test of motor educability.

(5) The Brace test is slightly superior to the Iowa revision of the Brace test as a measure of motor learning.

(6) Certain measures proposed to measure motor learning, namely, the general motor-ability score, general motor-capacity score, general motor-accomplishment quotient, and motor quotient do not appear to measure motor learning to a sufficient extent to be used to predict motor learning, as measured in this study.

(7) Because of its low relationship with motor learning there is grave question of the validity of the McCloy general motor-capacity score as a measure of motor capacity, if such capacity is understood to involve ability to learn.

Finally Brace\(^{40}\) reported a rather close relationship \((r = .793)\) between the balance items of the Brace Motor Ability test, and "total per cent gain" on three learning tests (all sport-type tests) for 50 feeble minded girls.

However, the reader should keep these two facts in mind as he considers the above statement:

1. These were feeble minded girls, and other relationships are reported for these girls that are known to be false with girls of normal intelligence.

2. Subsequent study of the scoring of these learning tests by Dr. Brace indicates that the "total learning score" is the best method of scoring these tests. The relationship reported above (r = .793) was between "total per cent gain" and the balance items of the Brace test. The "total learning score" on the three learning tests correlated .382 with the balance items of the Brace test.

IV. ISOLATED VARIABLES AND THEIR POSSIBLE RELATIONSHIP TO MOTOR LEARNING AND ACHIEVEMENT

Working with women students at the University of Michigan, Beise and Peasey found that significant differences between skilled and unskilled can be determined by a "S-A-R" (Speed, Agility, and Reaction Time) test. Confirming at least part of the above conclusion, Keller found a marked positive relationship between "ability to move the body quickly" and success in athletics. He reported further that quickness of bodily movement was more important in some activities than others.


Green reported that athletic ability is closely related to the rate of learning motor skills. Kirkner and Brace confirmed Green's conclusion.

Roth reported the following four generalizations on the relationship between hand-eye dominance and motor ability:

1. Motor ability varies with different combinations of hand-eye dominance.

2. The motor ability of crossed sinistrals (left handed and right eyed) is superior to individuals of any other type of hand-eye dominance.

3. The motor ability of pure sinistrals (left handed and left eyed) is inferior to individuals of any other type of hand-eye dominance.

4. The assumed superiority of pure dextral subjects (right handed and right eyed) is well founded. They ranked second highest of the six groups studied (left handed and right eyed, left handed and left eyed, left handed and either eyed, right handed and right eyed, right handed and left eyed, and right handed and either eyed). They were surpassed only by the crossed sinistrals.

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44 Pat J. Green, "Intercorrelations Between Factors Involved in the Study of the Rate of Learning Motor Skills" (Master's Thesis, University of Texas, 1936).

45 Kirkner, loc. cit.


On the relationship between kinesthesia and motor learning, Philips concluded:

1. The phrase "general kinesthetic sensitivity and control" is not justified unless reference is made to the sum of many specific abilities for kinesthesia is quite specific to the stimulus pattern involved.

2. Certain phases of kinesthesia show moderately low relationships with the early acquisition of two perceptuo-motor skills (golf skills—putting and driving), but these relationships are sometimes negative.

3. Partial correlation coefficients are larger in every instance between kinesthetic test scores and putting than they are between kinesthetic test scores and driving when the influence of factors such as age, body build, intelligence, and grip strength are statistically ruled out.

Barclay reported that there was no significant relationships between vision and success in "shooting baskets" in the game situation of basketball. (Thirteen tests were used to measure efficient vision and not a significant relationship was reported between "basketball

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shooting" and anyone of these tests.) Winogr 50 confirmed Barclay's conclusion reporting no relationship between vision and timing with the batting criteria of batting average, slugging average, and runs batted in amongst a group of experienced ball players. In Winograd's study timing did appear to distinguish varsity baseball players from non-athletes and rejected candidates.

V. OTHER NOTEWORTHY STUDIES PERTAINING TO MOTOR LEARNING

On learning and retention in motor learning Baer 51 reported:

1. For recall the fast learner, though better, is not significantly better than the slow learner in retention.

2. For relearning the fast learner, though better, is not significantly better than the slow learner in retention.

3. For loss the fast learner, though better, is not significantly better than the slow learner in retention.

Espenschade 52 reported the effects of specific instruction and practice on the Brace test and the Iowa-Brace test and its effect upon the validity of these measures. The subjects were two groups of women students at the University of California. Both groups were given the Brace and the Iowa-Brace tests during the second week of instruction. The instructional periods were reasonably identical except that instruction and practice on both tests were given in one group. At the end of sixteen weeks both groups were retested in terms


51 Reuben A. Baer, "The Relationship Between Rate of Learning and Retention in Several Motor Activities" (Doctoral Dissertation, John Hoskins University, 1940), pp. 36-37.

of both the Brace and the Iowa-Brace tests. Espenshade concluded that improvement in the scores made on the Brace and Iowa-Brace tests could be brought about during activity designed to develop bodily coordination, strength, flexibility, and control; but specific instruction in these tests did not influence the amount of improvement or the validity of these tests.

Seashore^{53} reported that motor ability consisted of specific skills (He worked with fine muscle skills.); and that sampling a serial performance of the same general neuromuscular coordinations involved would be the most likely approach for predicting success in a motor skill. Also experimenting with fine muscle skills, Freeman^{54} confirmed Seashore's conclusions favoring specific skills rather than a theory of general motor ability.

VI. SUMMARY OF THE FINDINGS OF OTHER RESEARCHES PERTINENT TO ANY STUDY OF MOTOR EDUCABILITY

The following statements attempt to summarize the most significant facts relevant to present status of motor educability testing:

1. There are "at least" two types of motor learning— that of the stunt-type and that of the sport-type.

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2. Individuals differ greatly in their ability to learn both stunt-type and sport-type skills.

3. Speed of learning stunt-type skills (stunt-type motor educability) is not highly related to speed of learning sport-type skills (sport-type motor educability).

4. The tests most commonly purported to measure motor educability are the Brace test, the Iowa-Brace test, and the Johnson test.

5. The Johnson test is a highly valid measure of stunt-type motor educability.

6. The Johnson test is considerably more valid than the Brace test or the Iowa-Brace test as a measure of stunt-type motor educability, although all three are relatively valid for this purpose.

7. The Brace test and the Iowa-Brace test are highly related.

8. Specific instruction and practice on the Brace and Iowa Brace test apparently do not affect the validity of these measures. (It probably would render standard scores for the measures invalid.)

9. Rate of learning swimming skills is not highly related to stunt-type motor educability as measured by the Brace test and the Iowa-Brace test.

10. Neither the Brace test, the Iowa-Brace test, nor the Johnson test is a valid measure of sport-type motor educability.

11. Sport-type motor educability is significantly related to athletic ability (McCloy's Athletic Index).
12. There is considerable question as to the validity of the McCloy general motor capacity test when the criterion is the ability to learn sport-type skills.
CHAPTER III

PROCEDURE

The subjects were 141 male college freshman students enrolled in required physical education classes at L.S.U. The data were gathered during regular required physical education periods. For the first nine weeks of the fall semester of 1953, these students served as subjects for this experiment and received full academic credit for participation in physical education during this time.

The criterion was a revision of four of the sport-type learning tests that have been used through the years as the criterion of motor educability in experimental studies at the University of Texas. The reliability of each test was determined by the split-halves procedure correlating the sum of the odd and the sum of the even trials. These correlations were then stepped up by the Spearman-Brown Prophecy Formula.¹

The experimental battery consisted of 49 tests. All of the items of the Brace Motor Ability Battery and the Iowa Revision of the Brace Battery for Senior High School Boys, selected tests from the

Johnson Battery, two agility tests, the 50 yard dash, thirteen additional tests devised by this writer, and short practical forms of the learning tests used as criteria composed this battery. The reliability of each test was determined whenever feasible by the test-retest method; wherever this method was impractical, the reliability was determined by the split-halves method correlating the sum of odd and the sum of the even trials. Split-halves correlations were stepped up by the Spearman-Brown Prophecy Formula.

The Wherry-Doolittle Method was used to select the best battery of tests to predict the criterion. Basically, the statistical procedure in this method (1) selects the test that will maximally predict the criterion, (2) applies the Wherry Shrinkage formula, (3) selects the second test to be added to the battery, (4) computes the multiple correlation coefficient (R) between the criterion and the two selected tests corrected for chance error, and (5) continues this procedure until maximum R is reached. Next the multiple regression equation for the selected battery was computed. ²

The validity of the Brace Motor Ability Test and the Iowa Revision of the Brace Test for Senior High School Boys as a measure of sport-type motor educability was checked by product-moment correlation.

² The Wherry-Doolittle Test Selection Method and the calculation of the regression equation for the selected battery can be found in most statistical tests of recent publication. These processes are explained in detail by Henry C. Garrett, Statistics in Psychology and Education (New York: Longmans, Green and Co., 1953), pp. 404-415.
Total scores for the batteries mentioned above on one, two, and ten trials were correlated with the criterion.

I. PILOT STUDY

The preliminary design for the study showed that several tests designated for use in the experimental battery were untried tests and that the tests in the criterion battery had been used previously only with girls. Therefore a pilot study was undertaken during the summer session of 1953. Thirty-two freshmen enrolled in two tennis classes at L.S.U. served as subjects for this study. The names of these subjects were retained and they were not included in the sampling procedure described below. As a result of this study this researcher gained experience giving the new tests and the tests in the criterion battery; eight of the new tests in the experimental battery were revised for clearer understanding and/or made easier or more difficult to perform as observations deemed necessary; and two of the four tests in the criterion battery were made much more difficult so that they might more effectively differentiate between college men.

II. METHOD OF SAMPLING

The population, universe, or supply which was to be represented by the sample were male North American college freshmen enrolled in the required physical education classes at L.S.U. in the fall of 1953. ³

³ Population, universe, and supply are defined as the "bulk that is being sampled" by Palmer O. Johnson, Statistical Methods in Research (New York: Prentice-Hall Inc., 1949), p. 187.
It is thought to be possible that some real differences might exist between students in the various sections. The better student might tend to register for the afternoon classes since more time is available for participation in those classes. A certain type of student might tend to register for Saturday classes and another type might not. To be assured of a sample that would be representative of the population, the Stratified-Random Sampling method was employed. Each section was considered a subdivision or stratum and subjects were selected proportionally and at random from each stratum. Randomness was secured in each stratum by assigning code numbers to all North American freshmen enrolled in each section and then selecting subjects by means of Kendall and Smith's Table of random numbers. Twenty subjects were selected from the section with the median enrollment. Subjects were selected proportionally from the other sections. The number of subjects selected in the various sections ranged from 17 to 23.

Times that the various sections met as well as the number of subjects per section are shown in Table I. The morning sections met three times weekly for periods of one-half hour each; the afternoon classes met twice weekly for periods of one hour each. A total of 137 subjects was selected from these seven regular activity sections.

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# TABLE I

**TIMES THAT SECTIONS MET AND NUMBER OF SUBJECTS PER SECTION**

<table>
<thead>
<tr>
<th>Time</th>
<th>Days</th>
<th>No. of Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:15 - 10:45 A.M.</td>
<td>Mondays, Wednesdays, and Fridays</td>
<td>21</td>
</tr>
<tr>
<td>11:15 - 11:45 A.M.</td>
<td>Mondays, Wednesdays, and Fridays</td>
<td>23</td>
</tr>
<tr>
<td>2:15 - 3:15 P.M.</td>
<td>Mondays and Wednesdays</td>
<td>18</td>
</tr>
<tr>
<td>9:15 - 9:45 A.M.</td>
<td>Tuesdays, Thursdays, and Saturdays</td>
<td>17</td>
</tr>
<tr>
<td>10:15 - 10:45 A.M.</td>
<td>Tuesdays, Thursdays, and Saturdays</td>
<td>20</td>
</tr>
<tr>
<td>11:15 - 11:45 A.M.</td>
<td>Tuesdays, Thursdays, and Saturdays</td>
<td>20</td>
</tr>
<tr>
<td>2:15 - 3:15 P.M.</td>
<td>Tuesdays and Thursdays</td>
<td>18</td>
</tr>
</tbody>
</table>

**Total** 137
In addition a group of physical education freshmen majors was meeting separately. Since they were part of the population represented in this study, a proportional number (4 men) was selected from this group by the random sampling method described above. Thus the total sample at the beginning of the study representing male North American college freshmen enrolled in required physical education classes at L.S.U. in the fall of 1953 was 141 subjects. For a variety of reasons, data were incomplete on 10 subjects. All findings are therefore based on 131 of the original 141 subjects.

III. THE CRITERION

Description of Tests. The tests used in the criterion battery are described below:

1. **Wall Volley Test.** The subject stands behind a line drawn three feet from a wall and volleys a volleyball above a line drawn on the wall ten and one-half feet above the floor. The volley is started with a two-handed toss against the wall. The number of volleys up to ten is recorded on each of thirty trials. The score stops on each trial when (1) ten points have been scored, or (2) the subject steps on or over the restraining line, or (3) a volley does not go above the line drawn on the wall, or (4) a "caught ball" is ruled by the scorer. The two-handed toss starting each volley counts one point. The total score for the test is the sum of the scores made on the thirty trials.

2. **Ball Bounce Test.** The subject stands in the middle of a circle six feet in diameter holding a medium weight softball bat one hand's length from the heavy end. The subject attempts to bounce a volleyball on the top of the bat (not on the side, but on the very top of the bat). The number of bounces up to ten is recorded on each of the thirty trials. The score stops on each trial when (1) ten points have been scored, or (2) the subject steps on or over the line bounding the six foot circle, or (3) the ball hits the subject's body, or (4) the ball does not go six inches above the end of the bat. The total score for this test is the sum of the scores made on the thirty trials.
3. **Target Toss.** The subject using a chest shot tosses a soccerball over a net at a horizontal target on the gymnasium floor. Three concentric circles, with diameters of one, three, and five feet, are used for the target. The net is stretched eight feet above a line drawn on the floor five feet from the outside circle of the target. The subject is required to stand behind a line drawn parallel to and five feet from the net on the opposite side of the target. Two throws are allowed on each of the thirty trials and the score on each trial is composed on the basis of five points for any ball hitting within or on the line bounding the inner circle and three points and one point for the middle and outer circles respectively.

4. **Kick Test.** In this test a soccerball is kicked at a target on a wall thirty feet away. Three concentric circles with diameters of one, three, and five feet are used for the target. Two kicks are allowed on each of the thirty trials, and the score on each trial is composed on the basis of five points given for any ball hitting within or on the line bounding the inner circle and three points and one point for the middle and outer circles respectively.

**Justification of the Tests.** Learning tests have been used as the criterion of rate of learning through the years at the University of Texas. This approach to the problem of a criterion of motor educability was first used by Hander and Kirkner. These researchers used five learning tests as the criterion of the speed of learning motor skills. These tests were used again as the criterion of motor

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educability by Brace. Later they were revised and used by Dunlap, revised further by Burch, used again by Brace, and used with a new scoring technique by McCraw. The learning tests used as the criterion in this study are a further revision of four of these sport-type learning tests.

The studies mentioned above have been accomplished either by Dr. Brace himself or under his supervision. He has used modifications of the learning tests used in this study as the criterion of sport-type learning because he believes that the learning taking place in these tests is indicative of the learning in sport-type activities and that these learning tests have not been previously practiced specifically as such. In the absence of any known criterion, this appears to be the most feasible approach to the problem. Since sport-type motor educability is by definition the quickness with which sport-type motor skills are learned, it seems reasonable to conclude that the quickness


9 Marie L. Dunlap, "Relationship Between Motor Learning and Certain Tests of Physical Abilities" (Master's Thesis, University of Texas, 1942), cited by McCraw, op. cit., p. 64.


13 Brace, loc. cit.
with which a group of sport-type motor skills are learned would be a cogent criterion of sport-type motor educability.

Nevertheless, in addition to the reliability factor, certain basic assumptions underlie the use of these learning tests as the criterion of sport-type motor educability. These assumptions are brought to the reader's attention:

1. There is some G or general factor present in sport-type motor learning. Students who learn quickly in one sport-type activity, as a generality will learn quickly in all sport-type activities, and vice-versa. As a generality there is a significant relationship as concerns "speed of learning" in all sport-type learning. Recent studies by Brace\(^{14}\) and McCraw\(^{15}\) confirm this assumption.

2. The learning tests have not been previously practiced specifically as such. While these learning tests are similar in kind to sport-type skills, inspection of the tests do reveal that these skills are not performed as such in any sport activity. Therefore, this assumption seems to be reasonable.

3. "Speed of learning" these learning tests is significantly related to "speed of learning" other sport-type skills. Brace feels (and this writer agrees) that these learning tests are typical of sport-type learning and may be classified as sport-type tests.\(^{16}\)

\(^{14}\) Brace, *loc. cit.*

\(^{15}\) McCraw, *op. cit.*, p. 323.

\(^{16}\) Brace, *loc. cit.*
follows that (1) if these are sport-type skills, and (2) if there is significant relationships as concerns "speed of learning" in all sport-type learning, then "speed of learning" these skills is significantly related to "speed of learning" other sport-type skills.

Method of Scoring Tests. Various methods of scoring the tests have been tried, compared, and evaluated by Dr. Brace and Dr. McCraw at the University of Texas. In light of the fact that so much of the recent research pertinent to rate of motor learning has been accomplished at the University of Texas, a letter was written to Dr. Brace requesting advice relevant to scoring the learning tests. He replied:

I believe that we have about come to the conclusion that the sum of the scores made on the trials in the learning tests constitutes about the best method of measuring improvement. 17

Use of this method of scoring is based upon the assumption that speed of learning a specific learning test is validly measured by the "total score" for that test. Since these tests have not been previously practiced specifically as such (this assumption has been discussed on page 40), students who learn the skills involved in a particular learning test quickly will receive high scores early in the thirty trials. Since fatigue does not appear to be a factor, students who earn higher scores early should receive higher total scores. Thus the rationale underlying this method of scoring appears to be justified.

After consideration of Dr. Brace's statement, the underlying assumption, and McGraw's study comparing the various methods of measuring improvement, it was decided to use the "sum of the scores" method to score the learning tests.

Computing the Composite Criterion. Each criterion test was correlated by product-moment correlation with every other criterion test. The tests were then arranged in hierarchical order to test the hypothesis of a common general factor. This step was basic to the computation of a composite criterion.

Test scores were then changed to Sten Scores. This gave each of the four tests equal weight regardless of the size of its raw score sigma. The sum of the Sten Scores on the four tests was used as the composite criterion score for each subject.

IV. THE EXPERIMENTAL BATTERY

Method of Scoring. Tests 1 through 10 are sport-type tests and were scored as follows: the subject has ten tries on each test. The score on each test is the number of successful attempts in ten tries. The maximum score on any one test was therefore ten.

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19 This test of a common general factor is discussed in greater detail in Chapter IV, "Discussion of Results."

20 Sten Scores are standard scores with a range of ten (0-9 inc.). The mean is 4.5; sigma is 2. The Sten Scale is presented by A. A. Canfield, "The Sten-Scale-A Modified C-Scale," Educational and Psychological Measurement (11:295-298, 1951).
Tests 11 through 35 are stunt-type tests and were scored as follows: ten points was still the maximum for any one test, which was scored by any subject performing the test correctly on the first attempt. The subject received nine points if he performed the stunt correctly on the second trial, eight on the third trial, and so forth. The subject continued to attempt the test only until he performed it correctly (no more than ten trials were allowed and the subjects rested for short intervals after every three trials). The subject was not required to take all ten trials as in tests 1 through 10 because (1) the nature of the tests are such that the possibilities of performing one merely by chance are thought to be very small, and (2) the tests are longer than the previous ones and there is the possibility that subjects might lose interest if asked to repeat a successful performance so many times, and (3) in some instances fatigue might become a factor in the later trials.

Tests 36 through 39 are four tests (also stunt-type) of the Johnson Battery. The maximum score on each of these tests is ten. These tests were scored as indicated in the description of said tests.

Tests 40 through 49 were also scored as indicated in the description of said tests. For the sake of classification tests 40 and 41 are called agility tests. Tests 42 through 49 are sport-type tests.

Description of Tests. Tests used in the Experimental Battery are described below:

1. Volleyball Throw Over Rope and Behind Back Catch. Subject takes a volleyball with both hands. Feet may be spread as far as subject likes. With either or both hands the subject attempts
to throw the ball vertically upward in the air over a rope stretched over his head and eight feet above the floor. He attempts to catch the ball behind his back. Feet may be maneuvered in order to get into position to catch ball. It is a failure (1) not to throw the ball over the rope that is stretched over his head and eight feet above the floor, and/or (2) not to catch the ball behind the back.

2. Soccerball Bounce and Hit Target Test. The subject throws a soccerball at a target on a wall from a line 25 feet away. The target is a circle 18 inches in diameter and its lower boundary is four feet from the floor. The ball must bounce once and only once before it hits the target. It is a failure (1) not to hit the target or the line bounding the target, and/or (2) not to bounce the ball once or to bounce the ball more than once before it strikes the target, and/or (3) to step over the starting line.

3. Lie On Back Throw Tennis Ball in Air and Catch. The subject lies flat on his back, holding a tennis ball. He throws the ball six feet or higher in the air and catches it in either hand while remaining in the "lying on back position." It is a failure (1) not to throw the ball at least six feet in the air, and/or (2) not to catch the ball in one hand, and/or (3) not to maintain the "lying on back" position during the entire procedure.

4. With One Soccerball Hit Other Soccerball in Air. The instructor standing in front of a wall throws a soccerball up in the air between 12 to 17 feet in height, and between two vertical lines four feet apart. The subject stands holding a second soccerball at a point 20 feet from the wall. The subject attempts to hit the first ball with the second ball while the first ball is still in flight. It is a failure to miss the ball in flight.

5. Roll Soccerball at 4 by 4. A soccerball is rolled with either hand at a piece of wood standing on edge from a point 10 yards away. The piece of wood is four inches in width, four inches in depth, and about twelve inches in length. It is a failure (1) not to hit the 4 by 4.

6. Toss Tennis Balls Over Head and Catch. The subject holds a tennis ball in each hand. He throws both tennis balls in the air simultaneously and attempts to catch both balls before they hit the ground. The balls must be thrown at a height above the subject's head. It is a failure (1) not to throw both balls simultaneously, and/or (2) not to catch both balls before either hits the ground, and/or (3) not to throw both balls above the subject's own head.
7. **Kick Ball at 4 by 4.** The subject attempts to kick a soccerball at a target 24 feet away. The target is a piece of wood four inches in width, four inches in depth, and about twelve inches long. It is a failure not to hit the target.

8. **Target Toss.** The subject throws a regulation softball at a target on a wall from a point 12 yards away. The target is a circle 18 inches in diameter whose lower boundary is four feet from the ground. It is a failure (1) to miss the target or the line bounding the target.

9. **Kick Ball at Target.** The subject attempts to kick a soccerball at a target on a wall 30 feet away. The target is a circle three feet in diameter whose center point is 30 inches from the ground. It is a failure not to hit the target or the line bounding the target.

10. **Throw Soccerball Against Wall and Hit Target Test.** The subject stands behind a line drawn parallel to and 20 feet away from a wall. He attempts to throw the ball against the wall so that it hits a target on the gymnasium floor on the rebound from the wall. The target is a circle 18 inches in diameter, whose center point is 10 feet from the wall. It is a failure (1) not to strike the wall on a fly, and/or (2) not to hit the target or the line bounding the target on the rebound from the wall.

11. **Walk in Straight Line (Brace Motor Ability Battery, Test #1).** Walk in a straight line, placing the heel of one foot in front of and against the toe of the other foot. Start with the left foot. Take ten steps in all, five with each foot. Eyes are open. It is a failure (1) to lose the balance and step out of the line, and/or (2) not to walk in a straight line, and/or (3) not placing heel to toe.

12. **Jump in Air, Clap Feet Together (Brace #2).** Stand, jump into the air and clap feet together once, and land with the feet apart (any distance). It is a failure (1) to land with the feet touching each other, and/or (2) not to clap the feet together in the air once.

13. **Lying on Back, Execute Arms Folded Sit-up (Brace #3).** Lie flat on the back on the floor. Fold the arms across the chest. Raise the trunk to a sitting position. Do not raise the feet above the floor, or unfold the arms. It is a failure (1) to raise

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21 This writer is indebted to Dr. D. K. Brace for permission both to experiment with his tests and to include in the final battery any tests that may be selected by the statistical procedure involved.
the feet above the floor (this does not include sliding the feet, which is permissible), and/or (2) to unfold arms, and/or (3) not to sit up.

14. **Stand** (Brace #4). Fold the arms behind the back. Kneel onto both knees. Get up without losing the balance or moving the feet about. It is a failure (1) to lose the balance either going down or getting up, and/or (2) to move the feet after standing up, and/or (3) to unfold the arms.

15. **Execute Three Rhythmical Jumps from Squat Position** (Brace #6). Squat on the toes with feet together and knees out, and hands between the knees with fingers touching the floor. Spring up onto both heels, with legs straight and toes up, and swinging both arms out at the side level with the floor. The feet should then be about 18 inches apart. Head is up. Repeat this exercise three times (in all) rhythmically. It is a failure (1) not to get the arms and legs in position, and/or (2) not to do it three times in succession without stopping.

16. **Full Turn in Air Test** (Brace #7). Stand with feet together. Jump into the air and make a full turn to the left, landing on the same spot. Do not lose the balance or move the feet after they strike the floor. It is a failure (1) not to get all the way around, and/or (2) to move the feet after they strike the ground.

17. **Double Heel Click** (Brace #8). Jump into the air and clap feet together twice and land with the feet apart (any distance). It is a failure (1) not to clap the feet together twice, and/or (2) to land with feet touching each other.

18. **One Foot Touch Knee Test** (Brace #9). Stand on the right foot. Grasp the left foot behind the right knee. Bend and touch the left knee to the floor and stand up without touching any other part of the body to the floor, or losing the balance. It is a failure (1) to touch the floor with any part of the body except the left knee, and/or (2) not to touch properly and stand with right leg straight, and without losing the balance.

19. **Jump in Air, Slap Hands to Heels Behind** (Brace #11). Jump into the air and slap both heels with the hands behind the back. It is a failure (1) not to touch both heels to hands, and/or (2) not to be able to regain the standing position after contact.
20. **Stand, Kick Right Foot in Air to Shoulder Level** (Brace #12). Stand, kick the right foot up so that the toes come at least level with the shoulders. Do not fall down on the floor. It is a failure (1) not to kick as high as the shoulders, and/or (2) to fall down or to touch the floor with any part of the body other than the feet.

21. **Full Turn to the Right** (Brace #15). Stand with both feet together. Swing the arms and jump up in the air, making a full turn to the right. Land on the same spot and do not lose the balance—that is, do not move the feet after they first strike the floor. It is a failure (1) not to make a full turn and land facing in the same direction as at the start, and/or (2) to lose the balance and have to step about to keep from falling.

22. **Cross Leg Squat** (Brace #17). Fold the arms across the chest. Cross the feet and sit down cross-legged. Get up without unfolding the arms or having to move the feet about to regain the balance. It is a failure (1) to unfold the arms, and/or (2) to lose the balance, and/or (3) to be unable to get up.

23. **Support Body on Hands for Five Seconds** (Brace #19). Take a squat rest position. That is, place the hands on the floor between the knees and close to the feet. Bend the elbows slightly and place both knees well over the elbows. Rock forward onto the hands. Hold the position for five seconds (as counted by the scorer). It is a failure (1) not to keep the body off the floor for at least five seconds.

24. **Left Knee Bend Test** (Brace #20). Stand on the left foot with the right foot extended forward off of the floor. Sit down on the heel of the left foot, without touching the right foot or hands to the floor. Stand full up without losing the balance. It is a failure (1) not to sit all the way down on the left heel, and/or (2) to touch the right foot or hands to the floor, and/or (3) not to stand up with the left leg straight before touching the right foot.

25. **One Foot-Touch Head** (Brace #13, Iowa-Brace for Senior High School Boys #1). Stand on the left foot. Bend forward and place both hands on the floor. Raise the right leg and stretch it back. Touch the head to the floor, and regain the standing position without losing the balance. It is a failure (1) not to touch the head to the floor, and/or (2) to lose the balance and have to touch the right foot down or step about.
26. **Forward Hand Kick (Iowa-Brace #2).** Jump upward, swinging the legs forward, bend forward and touch the toes with both hands before landing. Keep the knees as straight as possible. It is a failure (1) not to touch both feet while in the air, and/or (2) to bend the knees more than forty-five degrees.

27. **Kneel, Jump to Feet (Brace #16, Iowa-Brace #3).** Kneel on both knees. Extend the toes of both feet out flat behind. Swing the arms and jump to the feet without rocking back on the toes or losing the balance. It is a failure (1) to have the toes curled under and rock back on them, and/or (2) not to execute the jump, and to stand still on both feet.

28. **Stork Stand (Brace #18, Iowa-Brace #4).** Stand on the left foot. Hold the bottom of the right foot against the inside of the left knee. Place the hands on the hips. Shut both eyes and hold the position for ten seconds without shifting the left foot about on the floor. It is a failure (1) to lose the balance, and/or (2) to take the right foot down, and/or (3) to open the eyes or remove the hands from the hips.

29. **Single Squat Balance (Iowa-Brace #5).** Squat clear down on either foot. Stretch the other leg forward off the floor, hands on the hips. Hold this position for five counts. It is a failure (1) to move the hands from the hips, and/or (2) to touch the floor with the extended foot, and/or (3) to lose the balance.

30. **Grapevine (Brace #14, Iowa-Brace #6).** Stand with both heels tight together. Bend down, extend both arms down between the knees, around behind the ankles, and hold the fingers together in front of the ankles without losing the balance for five seconds. It is a failure (1) to fall over, and/or (2) not to touch and hold the fingers of both hands together, and/or (3) not to hold the position for five seconds.

31. **Three Dips (Brace #5, Iowa-Brace #7).** Take a front leaning-rest position—i.e., place the hands on the floor, with arms straight, extend the feet back along the floor until the body is straight (in an inclined position to the floor). Bend the arms, touching the chest to the floor, and push up again to straight arms. Do this three times in succession. Do not touch the floor with the legs or waist. It is a failure (1) not to push

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22 This writer is indebted to Dr. C. H. McCloy for permission both to experiment with his tests of the Iowa-Brace Battery and to include in the final battery any tests that may be selected by the statistical procedure involved.
up three times, and/or (2) not to touch the chest to the floor each time, and/or (3) to rest the knees, thighs, or waist on the floor at any time.

32. Side Kick (Iowa-Brace #8). Throw the left foot sideways to the left, jumping upward from the right foot; strike the feet together in the air and land with the feet apart. The feet should strike outside the left shoulder line. It is a failure (1) not to swing the feet enough to the side, and/or (2) not to strike the feet together in the air, and/or (3) not to land with the feet apart.

33. Russian Dance (Iowa-Brace #9). Squat clear down; stretch one leg forward; do a Russian dance step by hopping to this position with first one leg extended, then the other; do this twice with each leg. The heel of the forward foot may touch the floor. It is a failure (1) to lose the balance, and/or (2) not to do the stunt twice with each leg.

34. Jump Foot (Iowa-Brace #10, Brace #10). Hold the toes of either foot in the opposite hand. Jump up and jump the free foot over the foot that is held without letting go. It is a failure (1) to let go of the foot that is held, and/or (2) not to jump through the loop made by holding the foot.

35. Tangle Test. The subject is required to lie on a mat in a prone position with legs crossed at the ankles. The legs are then bent at the knees, lifting the crossed legs into the air so that the toes could be grasped with the hands behind the back. With the toes of the right foot held firmly in the left hand and those of the left foot in the right hand, the individual rolls over on his back. Next he rocks the body forward until the feet are flat on the floor and the body is in a position as upright as possible while still holding the toes with the hands. The legs are uncrossed by moving one in front of the other to its proper place, and then the individual stands erect after releasing the toes. The test is preceded by a demonstration. It is a failure not to be able to perform the stunt exactly as stated above.

Note: Tests number 36 through 39 were taken from the Johnson Test of motor educability. The test is given on a sheet of ten ounce canvas, 8 feet wide and 20 feet long, marked off according to the design shown in Figure 1. The pattern is a rectangle 4½ feet wide and 15 feet long, divided into squares 18 inches on a side. This makes three lanes 18 inches wide down the length of the chart. The main outline of the rectangle and the lines marking the lanes are painted in black lines 3/8 inch wide. The second, fourth, and alternate squares in the two
outside lanes are painted black. The center lane is not marked off in squares, but the first, third and other alternate spaces in this lane each contains a target 12 inches by three inches in the center of the square. There is an additional target placed outside the main pattern on the finish side. There is another lane two feet wide marked in red down the center of the canvas, divided halfway by a cross line of red. This is used only for the rolling exercises.

FIGURE 1

DIAGRAM OF A MAT COVER FOR JOHNSON TEST

36. **Straddle Jump** (Johnson Test #1). Hands on hips. Start with the feet together in first center target. Jump astraddle to first two black squares. Return to feet together position or second target. Proceed thus across the mat in regular jumps, finishing on the finish target. Scoring: Deduct 1 from the score for each jump in which the feet overstep the squares or miss the target; 1 for each jump in which the feet do not land at the same time; 1 if the hands are removed from the hips somewhere in the exercise; and 1 if rhythm is not maintained. If rhythm is broken more than once, it is penalized only the first time.

37. **Stagger Skip** (Johnson #2). Hands on hips. Start with feet together in front of right lane. Step with left foot on first center target and hop, still on left foot, to first black square on left. Step with right foot to second center target and hop, still on right foot to second black square on right. Continue in regular skips across mat. Scoring: Score as for Test 36, except that the feet do not come down together.

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23 This writer is indebted to Dr. Granville B. Johnson for permission both to experiment with his tests and to include in the final battery any tests that may be selected by the statistical procedure involved.
38. **Stagger Jump** (Johnson #3). Hands on hips, feet together throughout exercise. Start with feet together in front of right lane. Jump obliquely with both feet to first white square on left, then obliquely with both feet to first black square on right, then to second white square on left, finishing on finish target.

**Scoring:** Score as in Test 36.

39. **Forward Skip, Holding Opposite Foot from Behind** (Johnson #4). Start with feet together before either right or left lane (optional), hop with right foot into first white space, raising left foot behind and taking it with right hand behind right thigh at the same time. Hop in this position on right foot to first black space. Release left foot and leap with left foot to second white space, lifting right foot behind and taking it with left hand behind left thigh. Hop in this position on left foot to second black scoring space. Continue thus across mat.

**Scoring:** Deduct one for each step or jump in which the subject oversteps a square or in which he does not have the proper position of hand and opposite foot or both (Only one penalty is given for each square). Deduct 1 for lack of rhythm.

40. **The Crisscross Test**. Crossed lines three feet long are drawn in chalk on the floor. The subject stands in space 1, jumps with both feet to space 2, then to 3 to 4, and back to 1, continuing for fifteen seconds. The number of jumps minus the number of errors is the score. It is an error to jump on a line, to jump in the wrong place, to fail to alight on both feet at once. Falling is not an error if the subject does not fall on a line or into the wrong quadrant, as the loss of time is sufficient penalty.

![Diagram for the Crisscross Test](https://via.placeholder.com/150)

**FIGURE 2**

**DIAGRAM FOR THE CRISSCROSS TEST**

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41. **The Zig-Zag Run.** Four small objects are placed at the corners of a rectangle 10 feet wide and 16 feet long, and another is placed in the exact middle of the rectangle. Indian clubs, medicine balls, books, soft balls or any small object may be used. (In this study dressed 2 by 4's, twelve inches long were used.) The race is run starting at the line marked "start," the runner following the indicated path. He runs three complete laps, and is timed with a stop watch. His score is the time it takes to the nearest 1/10 of a second to run the three laps.

![Figure 3](image.png)

**FIGURE 3**

DIAGRAM FOR THE ZIG-ZAG RUN TEST

42. **Fifty Yard Dash.** Each subject is scored on his ability to run the fifty yard dash against time. His score is the time required to run the dash to the nearest 1/10 of a second.

43. **Hit One Soccerball in Air with Other Soccerball Using Chest Shot.** The instructor stands in front of a wall. Two horizontal, parallel lines are drawn on the wall 10 1/2 and 11 1/2 feet above the floor. The instructor throws the ball underhanded up in the air at a height between the two parallel lines. The subject stands behind a line ten feet from the wall and attempts to hit the first ball with a second ball while the first ball is in the air. The score is the number of successful attempts in 20 tries. If the subject does not throw for some reason, it does not count as a trial.

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44. **Throw Soccerball Overhand Against Wall and Hit Target on Rebound.** The subject stands behind a line drawn parallel to and 15 feet away from a wall. He attempts to throw the soccerball against the wall so that it hits a target on the gymnasium floor on the rebound from the wall. The target is a circle 24 inches in diameter whose center point is 10 feet from the wall. The throw must be overhand. It is a failure (1) not to strike the wall on a fly, and/or (2) not to strike the target or the line bounding the target on the rebound from the wall. The score is the number of successful attempts in 20 trials.

45. **Basketball Shooting.** The subject takes twenty shots from the free throw line. It is a failure not to make the basket. The score is the number of successful attempts in 20 trials.

46. **Short Form Wall Volley Test.** Test 46 is composed of the sum of the scores of the first seven trials of the wall volley test used as Test 1 in the criterion battery.

47. **Short Form Ball Bounce Test.** This test is the sum of the scores made on the first ten trials of the Ball Bounce Test used as Test 2 in the criterion battery.

48. **Short Form Target Toss.** This test is the sum of the scores made on the first six trials of the Target Toss used as Test 3 in the criterion battery.

49. **Short Form Kick Test.** Test 47 is the sum of the scores made on the first five trials of the Kick Test used as Test 4 in the criterion battery.

**V. RELATIONSHIP TO STRENGTH AND POWER**

McCloy, who first used the term Motor Educability, believes that tests which correlate relatively high with strength or power

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26 Tests 46 through 49 in the experimental battery are short practical forms of the identical four learning tests composing the criterion battery. This study assumes that the criterion is "sport-type motor educability." The rationale underlying this assumption has already been detailed. It is the task of this writer, therefore, to select a battery of **short practical tests** that will maximally predict this criterion. It matters not that these four tests are usable forms of learning tests used in the criterion.
should not be included in a test battery of motor educability. Motor educability is the quickness with which new skills are learned and as such should not be dependent upon strength and/or power. In keeping with McCloy's terminology, it was decided that a test highly dependent upon strength and/or power would be excluded from the experimental battery. A letter was written to Dr. McCloy asking how high a test could correlate with strength and/or power and still be considered a test of motor educability. The latter answered: "In general I would say that anything that correlated much higher than .35 or .4 with strength or power, I would reject as a test measuring motor educability." In accordance with this statement, .4 was set as the dividing point. Tests correlating above .4 with strength and/or power were discarded from the experimental battery.

Measuring Strength. Chinning strength was used as the measure of total strength. Chinning strength as determined by McCloy's formula, 

\[ \text{Chinning Strength} = 1.77 \times \text{weight} + 3.42 \times \text{number of chins} - 46, \]

has been shown to correlate about .9 with total strength. The


palms-out grip was used and chinning strength was correlated with each experimental test by product-moment correlation.

**Measuring Power.** Power is defined by McCloy\(^3\) as the "rate of doing work." The Sargent jump is the most used and most recommended measure of body power.\(^3\) Dalen\(^3\) describes the Sargent Jump as a test of the subject's ability to develop power relative to his weight and size.

The leaprometer was used to measure the height of the vertical jump. The subject was told to forget about the harness on his head and to jump up in the air as high as he could. Instructions on the mechanics of the jump were given only as observations deemed advisable. A subject was allowed to jump until he felt that he had reached his best performance. In no case did a subject stop as long as his jumps were improving.\(^3\) Power was correlated with each experimental test by product-moment correlation.

\(^3\) McCloy, *op. cit.,* p. 56.


\(^3\) It is of interest to note that in about 50% of the cases the best jump was the very first one. Attention to form at this early learning stage resulted in poorer performance in about 50% of the cases.
CHAPTER IV

DISCUSSION OF RESULTS

I. RELIABILITY AND INTERRELATIONSHIPS OF CRITERION TESTS

Reliability. The Reliability Coefficients of the criterion tests were determined by the odd-even method. The sum of the scores on the odd numbered trials were correlated with the sum of the scores on the even numbered trials. These correlation coefficients were then stepped up by the Spearman-Brown prophecy formula. The stepped up reliability coefficients are shown in Table II. It will be noted that

<table>
<thead>
<tr>
<th>Test</th>
<th>Reliability Coefficient</th>
<th>Confidence Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Volley</td>
<td>.9265</td>
<td>1%</td>
</tr>
<tr>
<td>Ball Bounce</td>
<td>.9508</td>
<td>1%</td>
</tr>
<tr>
<td>Target Toss</td>
<td>.8197</td>
<td>1%</td>
</tr>
<tr>
<td>Kick Test</td>
<td>.8861</td>
<td>1%</td>
</tr>
</tbody>
</table>
all of the coefficients are above .8. Apparently the reliability of every test is satisfactory.

**Interrelationships of Criterion Tests.** Intercorrelations of criterion tests are shown in Table III. It seemed worthy to test the hypothesis that a single general factor operates in these four sport-type learning tests. Test 2 (Ball Bounce) correlates highest with the other tests. Therefore, in Table IV tests are sorted in order of the magnitude of their correlation with Test 2. This table reveals that Test 2 (Ball Bounce) is more related to every test than any other test and that as tests are ranked in order of the magnitude of their correlation with Test 2, so are they ranked in the order of the

### Table III

**INTERCORRELATIONS OF CRITERION TESTS**

<table>
<thead>
<tr>
<th>Variable</th>
<th>( X_1 )</th>
<th>( X_2 )</th>
<th>( X_3 )</th>
<th>( X_4 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wall Volley</td>
<td>-----</td>
<td>.6552</td>
<td>.4069</td>
<td>.2767</td>
</tr>
<tr>
<td>2. Ball Bounce</td>
<td>-----</td>
<td>( X_2 )</td>
<td>.5783</td>
<td>.4319</td>
</tr>
<tr>
<td>3. Target Toss</td>
<td>-----</td>
<td>( X_3 )</td>
<td>( X_4 )</td>
<td>.2549</td>
</tr>
<tr>
<td>4. Kick Test</td>
<td>( X_1 )</td>
<td>( X_2 )</td>
<td>( X_3 )</td>
<td>( X_4 )</td>
</tr>
</tbody>
</table>
magnitude of their correlation with every other test. These observations warrant the following generalizations:

1. There is a common general factor operating in all four of these variables. That there is a common general factor present in sport-type learning was the first basic assumption of this study. Studies were cited which seemed to justify this assumption. The identification of a common general factor in these four sport-type tests further affirms the conclusions of those studies and the assumptions underlying the use of this criterion. If there is a common general factor present in sport-type learning, it follows that students will learn other sport-type skills at the same relative rate that these

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were learned. Therefore, the rate of learning these tests is a justifiable criterion of sport-type motor educability.

2. Test 2 (Ball Bounce) is heaviest loaded with this common general factor. Test 4 (Kick Test) is heaviest loaded with specific factors.

The Ball Bounce test and its relationship to the composite criterion. The test of a common general factor detailed above reveals that Test 2 (Ball Bounce) is heaviest loaded with this common general factor. The possibility existed that this test alone might predict the criterion better than the battery selected by the Wherry-Doolittle Test Selection Method. Since the long form of this one test alone could easily be given to twenty-five students in about forty minutes, there is no reason why it could not be used to predict sport-type motor educability for college men. Therefore, this test was correlated with the composite criterion, and the resulting correlation coefficient was .7488. Computation of the coefficient of determination reveals that 56 per cent of the variance in the criterion is determined by variance in Test 2 (Ball Bounce).^2

II. DISCARDING TESTS IN EXPERIMENTAL BATTERY

Tests numbered 11 (Walk in a Straight Line), 12 (Jump, Clap Feet Together), 13 (Arms Folded Sit Up), 20 (Kick Right Foot Shoulder),

25 (One Foot—Touch Head), 30 (Grapevine), and 31 (Three Dips) were arbitrarily labeled "too easy for college men" and were discarded without further consideration. Over 90 per cent of the men in this study performed these stunts correctly on their first trial. These tests may be of value for lower age groups or with girls, but apparently they are too easy to be of any value for college men. It is recommended that future researchers working with college men discard these tests from their respective batteries. They are time consuming and are too easy to be of any value for similar groups.

Due to continued inclement weather during the last week of testing, considerable data were incomplete on Test 42 (Fifty Yard Dash). This test too was discarded without further consideration.

The reliability of the remaining tests was next determined by product moment correlation. For stunt-type tests the test-retest method was used. For sport-type tests the odd-even method was used correlating the sum of the odd numbered trials with the sum of the even numbered trials. Odd-even correlation coefficients were stepped up by the Spearman-Brown prophecy formula. Reliability coefficients of tests composing the experimental battery are shown in Table V.

Brokaw\(^3\) has demonstrated that highly valid and highly reliable batteries can be composed of tests whose individual reliabilities are quite low. He suggests that the acceptable reliability coefficient of an individual test can be comparatively low if it is to be added to a

<table>
<thead>
<tr>
<th>Test</th>
<th>Reliability Coefficient</th>
<th>Confidence Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volleyball throw-catch</td>
<td>.6903</td>
<td>1%</td>
</tr>
<tr>
<td>Bounce and hit target</td>
<td>.4028</td>
<td>1%</td>
</tr>
<tr>
<td>Lie, throw tennis ball-catch</td>
<td>.6036</td>
<td>1%</td>
</tr>
<tr>
<td>Overhand hit moving target</td>
<td>.2284</td>
<td>5%</td>
</tr>
<tr>
<td>Roll ball at 4 by 4</td>
<td>.3451</td>
<td>1%</td>
</tr>
<tr>
<td>Tennis ball-throw-catch</td>
<td>.5498</td>
<td>1%</td>
</tr>
<tr>
<td>Kick ball at 4 by 4</td>
<td>.4066</td>
<td>1%</td>
</tr>
<tr>
<td>Target toss</td>
<td>.5158</td>
<td>1%</td>
</tr>
<tr>
<td>Kick ball at target</td>
<td>.5277</td>
<td>1%</td>
</tr>
<tr>
<td>&quot;Hit floor target on rebound&quot;</td>
<td>.1301</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Stand</td>
<td>.9240</td>
<td>1%</td>
</tr>
<tr>
<td>Rhythmical jumps</td>
<td>.9346</td>
<td>1%</td>
</tr>
<tr>
<td>Fall turn in air test</td>
<td>.8271</td>
<td>1%</td>
</tr>
<tr>
<td>Double heel click</td>
<td>.8848</td>
<td>1%</td>
</tr>
<tr>
<td>One foot touch knee</td>
<td>.9520</td>
<td>1%</td>
</tr>
<tr>
<td>Jump, slap hands to heels</td>
<td>.9686</td>
<td>1%</td>
</tr>
<tr>
<td>Fall turn to right</td>
<td>.8074</td>
<td>1%</td>
</tr>
<tr>
<td>Cross leg squat</td>
<td>.9901</td>
<td>1%</td>
</tr>
<tr>
<td>Hands balance five seconds</td>
<td>.9277</td>
<td>1%</td>
</tr>
<tr>
<td>Left leg knee bend</td>
<td>.9522</td>
<td>1%</td>
</tr>
<tr>
<td>Forward hand kick</td>
<td>.9396</td>
<td>1%</td>
</tr>
<tr>
<td>Kneel, jump to feet</td>
<td>.9525</td>
<td>1%</td>
</tr>
<tr>
<td>Stork stand</td>
<td>.8512</td>
<td>1%</td>
</tr>
<tr>
<td>Single squat balance</td>
<td>.9147</td>
<td>1%</td>
</tr>
<tr>
<td>Side kick</td>
<td>.9196</td>
<td>1%</td>
</tr>
<tr>
<td>Russian dance</td>
<td>.9675</td>
<td>1%</td>
</tr>
<tr>
<td>Jump foot</td>
<td>.9721</td>
<td>1%</td>
</tr>
<tr>
<td>Tangle test</td>
<td>.9786</td>
<td>1%</td>
</tr>
<tr>
<td>Straddle jump</td>
<td>.4119</td>
<td>1%</td>
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<tr>
<td>Stagger skip</td>
<td>.5016</td>
<td>1%</td>
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<tr>
<td>Stagger jump</td>
<td>.1277</td>
<td>Insignificant</td>
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<tr>
<td>Opposite foot behind skip</td>
<td>.4743</td>
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</tr>
<tr>
<td>Crisscross</td>
<td>.6657</td>
<td>1%</td>
</tr>
<tr>
<td>Zig-zag run</td>
<td>.8763</td>
<td>1%</td>
</tr>
<tr>
<td>Chest shot moving target</td>
<td>.6627</td>
<td>1%</td>
</tr>
<tr>
<td>Overhand hit target rebound</td>
<td>.6167</td>
<td>1%</td>
</tr>
<tr>
<td>Basketball shooting</td>
<td>.6715</td>
<td>1%</td>
</tr>
<tr>
<td>Short wall volley test</td>
<td>.7459</td>
<td>1%</td>
</tr>
<tr>
<td>Short ball bounce test</td>
<td>.8654</td>
<td>1%</td>
</tr>
<tr>
<td>Short target toss</td>
<td>.4759</td>
<td>1%</td>
</tr>
<tr>
<td>Short kick test</td>
<td>.5648</td>
<td>1%</td>
</tr>
</tbody>
</table>
battery. Therefore .5 was arbitrarily set as the dividing point. Tests whose reliability coefficients were below .5 were considered too unreliable for further consideration. On this basis Tests 2 (Bounce and Hit Target), 4 (Overhand Hit Moving Target), 5 (Roll Ball at 4 by 4), 7 (Kick Ball at 4 by 4), 10 (Hit Floor Target on Rebound), 36 (Straddle Jump), 38 (Stagger Skip), 39 (Skip, Holding Opposite Foot Behind), and 48 (Short Target Toss) were discarded at this point.

The following generalizations based on Table V are brought to the readers' attention at this point:

1. Generally, stunt-type tests similar to those in the Brace and Iowa-Brace batteries are more reliable than sport-type tests. Reliability coefficients are considerably higher for stunt-type tests than for sport-type tests. The median reliability coefficient for the stunt-type tests was .9396; for the sport-type tests the median reliability coefficient was .5648. Apparently chance is a bigger factor in sport-type tests than in stunt-type tests.

2. Future researchers using "untried" sport-type tests are cautioned to keep the number of trials to a minimum of twenty. Of the ten new sport-type tests involving only ten trials (tests numbered 1 through 10) used in this study, five have reliability coefficients below .5; eight have reliability coefficients below .6; all ten have reliability coefficients below .7.

Tests not discarded for reasons of difficulty, incomplete data, or reliability were correlated with strength (McCloy's chinning strength) and power (Sargent Jump). Correlations between the remaining tests and strength and power are shown in Table VI. Any test
### TABLE VI

**RELATIONSHIPS BETWEEN EXPERIMENTAL TESTS AND STRENGTH AND POWER**

<table>
<thead>
<tr>
<th>Tests</th>
<th>Strength Confidence Level</th>
<th>Power Confidence Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volleyball throw-catch</td>
<td>.23354</td>
<td>.3700</td>
</tr>
<tr>
<td>Lie, throw tennis ball-catch</td>
<td>.0997 Insignif.</td>
<td>.2570</td>
</tr>
<tr>
<td>Tennis balls-throw-catch</td>
<td>.0666 Insignif.</td>
<td>.2038</td>
</tr>
<tr>
<td>Target toss</td>
<td>-.0156 Insignif.</td>
<td>-.0337 Insignif.</td>
</tr>
<tr>
<td>Kick ball at target</td>
<td>.1854 5%</td>
<td>.0814 Insignif.</td>
</tr>
<tr>
<td>Stand</td>
<td>-.1587 Insignif.</td>
<td>.1274 Insignif.</td>
</tr>
<tr>
<td>Rhythmical jumps</td>
<td>.0471 Insignif.</td>
<td>.2381 1%</td>
</tr>
<tr>
<td>Full turn in air test</td>
<td>-.0827 Insignif.</td>
<td>.1928 5%</td>
</tr>
<tr>
<td>Double heel click</td>
<td>.0798 Insignif.</td>
<td>.2587 1%</td>
</tr>
<tr>
<td>One foot touch knee test</td>
<td>-.1355 Insignif.</td>
<td>.2259 5%</td>
</tr>
<tr>
<td>Jump, slap hands to heels</td>
<td>-.0503 Insignif.</td>
<td>.1317 Insignif.</td>
</tr>
<tr>
<td>Full turn to right</td>
<td>-.0161 Insignif.</td>
<td>.2159 5%</td>
</tr>
<tr>
<td>Cross leg squat</td>
<td>-.0938 Insignif.</td>
<td>.0421 Insignif.</td>
</tr>
<tr>
<td>Hands balance five seconds</td>
<td>.0093 Insignif.</td>
<td>.2232 5%</td>
</tr>
<tr>
<td>Left leg knee bend test</td>
<td>-.1098 Insignif.</td>
<td>.2899 1%</td>
</tr>
<tr>
<td>Forward hand kick</td>
<td>-.0086 Insignif.</td>
<td>.2436 1%</td>
</tr>
<tr>
<td>Kneel, jump to feet</td>
<td>-.1624 Insignif.</td>
<td>.2275 5%</td>
</tr>
<tr>
<td>Stork stand</td>
<td>-.1652 Insignif.</td>
<td>.0082 Insignif.</td>
</tr>
<tr>
<td>Single squat balance</td>
<td>-.2656 1%</td>
<td>.1875 5%</td>
</tr>
<tr>
<td>Side kick</td>
<td>-.0873 Insignif.</td>
<td>.2054 5%</td>
</tr>
<tr>
<td>Russian Dance</td>
<td>-.0148 Insignif.</td>
<td>.2646 1%</td>
</tr>
<tr>
<td>Jump foot</td>
<td>-.1247 Insignif.</td>
<td>.4588 1%</td>
</tr>
<tr>
<td>Tangle test</td>
<td>-.2715 1%</td>
<td>.0741 Insignif.</td>
</tr>
<tr>
<td>Stagger skip</td>
<td>-.2427 1%</td>
<td>.1929 5%</td>
</tr>
<tr>
<td>Crisscross test</td>
<td>.0309 Insignif.</td>
<td>.2938 1%</td>
</tr>
<tr>
<td>The zig-zag run</td>
<td>.0563 Insignif.</td>
<td>.2745 1%</td>
</tr>
<tr>
<td>Chest shot-moving target</td>
<td>.2237 5%</td>
<td>.2633 1%</td>
</tr>
<tr>
<td>Overhand hit target rebound</td>
<td>.0946 Insignif.</td>
<td>.2025 5%</td>
</tr>
<tr>
<td>Basketball shooting</td>
<td>-.0315 Insignif.</td>
<td>.0233 Insignif.</td>
</tr>
<tr>
<td>Short wall volley test</td>
<td>.1443 Insignif.</td>
<td>.2528 1%</td>
</tr>
<tr>
<td>Short ball bounce test</td>
<td>.1416 Insignif.</td>
<td>.2151 5%</td>
</tr>
<tr>
<td>Short kick test</td>
<td>.0618 Insignif.</td>
<td>.0412 Insignif.</td>
</tr>
</tbody>
</table>
correlating above .4 with strength or power was to be discarded from the battery. On this basis test 34 (Jump Foot) was discarded at this point. Of the original 49 tests in the experimental battery, this left 31 tests from which to select a battery which would maximally predict the criterion.

Based on Table VI, the following statements are brought to the readers' attention:

1. None of the tests in the experimental battery is highly dependent (above .4) upon "total strength."

2. Only about 19% of the correlations between strength and these tests are statistically significant (5% level of confidence).

3. Of the correlations between strength and these tests that are statistically significant, 50 per cent are negative relationships. 

4. One of the tests (34—Jump Foot) is highly dependent (above .4) upon power.

5. About 72 per cent of the correlations between power and these tests are statistically significant. All of these are positive relationships.

6. Power seems to be about equally related to both sport-type and stunt-type tests. The median correlation between sport-type tests and power was .2025, the median correlation between stunt-type tests and power was .2159.

---

It was this writer's observation that "total strength" is highly dependent upon weight. It is his opinion further that "total strength" is not significantly related to one's ability to chin himself or do push-ups. This may partially explain the first three statements based on Table VI.
III. SELECTING THE MOST VALID BATTERY

AND COMPUTING THE MULTIPLE REGRESSION EQUATION

Each test not discarded for reasons of difficulty, reliability, or relationship to strength and/or power was correlated with every other test and with the criterion by product moment correlation. These correlations are shown on Table VII. It will be noted that Tests 34 (Jump Foot), 50 (Strength), and 51 (Power) are included in this matrix of two variable correlations. These tests were not included in the test selection problem (It will be noted that Test 34 had been discarded because it was "too highly dependent upon power."); however, since correlation coefficients were available between these tests and every other test, they are included in the matrix for whatever interest they may be to the reader.

With 129 degrees of freedom a correlation coefficient of approximately .218 is needed for significance at the 1 per cent level of confidence; about .167 is needed at the 5 per cent level of confidence. 5

Table VII indicates further that stunt and sport-type learning are not highly related. Approximately 82 per cent of the sport-type tests correlate above .3 with the criterion. Approximately 21 per cent of the stunt-type tests correlate above .3 with the criterion.

---

<table>
<thead>
<tr>
<th>Test</th>
<th>Code</th>
<th>Description</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Vertical-throw test</td>
<td>10.4</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Knee bend test</td>
<td>10.6</td>
<td>1.4</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Single-squat test</td>
<td>10.9</td>
<td>1.3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Short-wall test</td>
<td>10.5</td>
<td>1.6</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>Short-kick test</td>
<td>10.2</td>
<td>1.8</td>
</tr>
</tbody>
</table>

**Table VII**

<table>
<thead>
<tr>
<th>Test</th>
<th>Code</th>
<th>Description</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Vertical-throw test</td>
<td>10.4</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Knee bend test</td>
<td>10.6</td>
<td>1.4</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Single-squat test</td>
<td>10.9</td>
<td>1.3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Short-wall test</td>
<td>10.5</td>
<td>1.6</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>Short-kick test</td>
<td>10.2</td>
<td>1.8</td>
</tr>
</tbody>
</table>

**Note:** The table above shows the mean and standard deviation for various strength and flexibility tests. The code for each test is listed next to the description. The data is based on a sample of 100 individuals.
Approximately 45 per cent of the sport-type tests correlate above .4 with the criterion. None of the stunt-type tests correlate above .4 with the criterion.

**The Most Valid Battery.** The Wherry-Doolittle Test Selection Method was used to select the smallest number of tests which would maximally predict the criterion. The first test selected by this method was Test 46 (Short Wall Volley Test). This test alone correlated .6080 with the criterion ($r_{c,46} = .6080$).

The second selected test to be added to the battery was Test 3 (Lie, Throw Tennis Ball - Catch). The multiple correlation ($R$) between the criterion and the two selected tests corrected for chance errors was .7034 ($R_{C,46,3} = .7034$). Since this is higher than the correlation between the criterion and Test 46 alone, a third test was selected.

The third selected test to be added to the battery was Test 47 (Short Ball Bounce Test). $R$ between the criterion and the three selected tests corrected for chance errors was .7576 ($R_{C,46,3,47} = .7576$). Since this is considerably higher than the correlation between the criterion and the two previously selected tests, a fourth test was selected.

The fourth selected test to be added to the battery was Test 45 (Basketball Shooting). $R$ between the criterion and the four selected tests was .7897 ($R_{C,46,3,47,45} = .7897$). Since this is considerably higher than the correlation between the criterion and the three previously selected tests, a fifth test was selected.
The fifth selected test to be added to the battery was Test 43 (Chest Shot-Moving Target). R between the criterion and the five selected tests was .7801 \( (R_{c.46,3,47,45,43} = .7801) \). The point of diminishing returns has been reached; the addition of no other tests in the experimental battery will increase the multiple correlation.

Four tests constitute the battery that will give the highest validity of any combination of tests from this experimental group of 31 tests. The four tests are Tests 46 (Short Wall Volley Test), 3 (Lie, Throw Tennis Ball-Catch), 47 (Short Ball Bounce Test), and 45 (Basketball Shooting). The multiple correlation between these four tests and the criterion is .7397 \( (R_{c.46,3,47,45} = .7397) \).

Computing the Multiple Regression Equation. The beta weights were next solved and converted to weights (raw score form). The regression equation to predict the criterion in sigma-score form is:

\[
Z_c = .32602Z_{46} + .2142Z_3 + .2401Z_{47} + .2802Z_{45}
\]

When scores on the indicated tests in standard score form are substituted in the above regression equation, predicted scores result which correlate .7897 with the criterion.

---

6 This validity coefficient (.7897) for the selected battery is higher than the validity coefficient (.7488) reported for the long form of the Ball Bounce test. A coefficient of .7897 indicates that 62 per cent of the variance in the criterion is accounted for by variance in this selected battery. A coefficient of .7488 indicates that 56 per cent of the variance in the criterion is accounted for by variance in the long form of the Ball Bounce test.
To write the equation in raw score form the beta’s must be converted to b’s (or w’s). Having solved for the b’s the equation is now written in raw score form as follows:

\[ \bar{X}_o = 7.1744X_{46} + 17.2857X_{3} + 2.7014X_{47} + 19.2265X_{45} \]

When raw scores on Tests 46, 3, 47, and 45 are substituted in the above regression equation, predicted scores result which correlate .7897 with the criterion.

IV. RELIABILITY ESTIMATES OF THE SELECTED BATTERY

Two random samples of twenty cases each were used to get two separate reliability estimates. Every sixth subject in the study was used as sample one. Subject number 4 and every sixth subject thereafter (subject number 10, 16, etc.) were used as sample two.

The reliability estimate of the battery for each sample was determined in the following manner. A subject’s total score on the odd numbered trials for each selected test was put in the raw score regression equation above. Solving of the equation resulted in one total score of all odd numbered trials. The same was done for even numbered trials. This procedure gave two scores for every individual in samples one and two. The reliability estimate for each sample was determined by correlating these two scores by product moment correlation. The resulting reliability coefficients for samples one and two respectively are .9136 and .8882. Apparently the reliability of the
battery is satisfactory. With 18 degrees of freedom a correlation coefficient of .561 is needed for significance at the 1% level of confidence. 7

V. CONVERTING PREDICTED RAW SCORES TO STANDARD SCORES

Table VIII is submitted for simple conversions of raw predicted scores to meaningful standard scores with a mean of 50 and a sigma of 10. 8

VI. VALIDITY OF THE BRACE AND THE IOWA-BRACE TESTS
AS MEASURES OF SPORT-TYPE MOTOR EDUCABILITY FOR COLLEGE MEN

To test the validity of the Brace and Iowa-Brace tests as measures of sport-type motor educability for college men, total scores for both batteries on one, two, and ten trials were correlated with the criterion. On one trial the tests in both batteries were scored on the basis of one point for each test successfully performed. On two trials the tests were scored on the basis of two points for every test successfully performed on the first trial and one point for every test performed successfully on the second trial (scoring on any one test stops with one successful performance). On ten trials the


8 There is a slight difference between T-scores and standard scores with a mean of 50 and a sigma of 10. This difference is detailed by Henry C. Garrett, Statistics in Psychology and Education (New York, London, and Toronto: Longmans, Green and Co., 1953), pp. 312-314.
<table>
<thead>
<tr>
<th>R</th>
<th>S</th>
<th>R</th>
<th>S</th>
<th>R</th>
<th>S</th>
</tr>
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<tbody>
<tr>
<td>1391 - Up</td>
<td>100</td>
<td>910 - 925</td>
<td>71</td>
<td>444 - 460</td>
<td>43</td>
</tr>
<tr>
<td>1375 - 1390</td>
<td>99</td>
<td>893 - 909</td>
<td>70</td>
<td>428 - 443</td>
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<tr>
<td>1358 - 1374</td>
<td>98</td>
<td>876 - 892</td>
<td>69</td>
<td>411 - 427</td>
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<td>1342 - 1357</td>
<td>97</td>
<td>860 - 875</td>
<td>68</td>
<td>395 - 410</td>
<td>40</td>
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<tr>
<td>1325 - 1341</td>
<td>96</td>
<td>843 - 859</td>
<td>67</td>
<td>378 - 394</td>
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<tr>
<td>1308 - 1324</td>
<td>95</td>
<td>827 - 842</td>
<td>66</td>
<td>361 - 377</td>
<td>38</td>
</tr>
<tr>
<td>1292 - 1307</td>
<td>94</td>
<td>810 - 826</td>
<td>65</td>
<td>345 - 360</td>
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<tr>
<td>1275 - 1291</td>
<td>93</td>
<td>793 - 809</td>
<td>64</td>
<td>328 - 344</td>
<td>36</td>
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<tr>
<td>1258 - 1274</td>
<td>92</td>
<td>777 - 792</td>
<td>63</td>
<td>312 - 327</td>
<td>35</td>
</tr>
<tr>
<td>1242 - 1257</td>
<td>91</td>
<td>760 - 776</td>
<td>62</td>
<td>295 - 311</td>
<td>34</td>
</tr>
<tr>
<td>1225 - 1241</td>
<td>90</td>
<td>743 - 759</td>
<td>61</td>
<td>278 - 294</td>
<td>33</td>
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<tr>
<td>1209 - 1224</td>
<td>89</td>
<td>727 - 743</td>
<td>60</td>
<td>262 - 277</td>
<td>32</td>
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<tr>
<td>1192 - 1208</td>
<td>88</td>
<td>710 - 726</td>
<td>59</td>
<td>245 - 261</td>
<td>31</td>
</tr>
<tr>
<td>1175 - 1191</td>
<td>87</td>
<td>693 - 709</td>
<td>58</td>
<td>230 - 244</td>
<td>30</td>
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<tr>
<td>1159 - 1174</td>
<td>86</td>
<td>677 - 693</td>
<td>57</td>
<td>212 - 229</td>
<td>29</td>
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<tr>
<td>1142 - 1158</td>
<td>85</td>
<td>660 - 676</td>
<td>56</td>
<td>195 - 211</td>
<td>28</td>
</tr>
<tr>
<td>1126 - 1141</td>
<td>84</td>
<td>644 - 659</td>
<td>55</td>
<td>179 - 194</td>
<td>27</td>
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<tr>
<td>1109 - 1125</td>
<td>83</td>
<td>627 - 643</td>
<td>54</td>
<td>162 - 178</td>
<td>26</td>
</tr>
<tr>
<td>1092 - 1108</td>
<td>82</td>
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<td>53</td>
<td>145 - 161</td>
<td>25</td>
</tr>
<tr>
<td>1076 - 1091</td>
<td>81</td>
<td>594 - 610</td>
<td>52</td>
<td>129 - 144</td>
<td>24</td>
</tr>
<tr>
<td>1059 - 1075</td>
<td>80</td>
<td>577 - 593</td>
<td>51</td>
<td>112 - 128</td>
<td>23</td>
</tr>
<tr>
<td>1042 - 1058</td>
<td>79</td>
<td>561 - 576</td>
<td>50</td>
<td>96 - 111</td>
<td>22</td>
</tr>
<tr>
<td>1026 - 1041</td>
<td>78</td>
<td>544 - 560</td>
<td>49</td>
<td>79 - 95</td>
<td>21</td>
</tr>
<tr>
<td>1009 - 1025</td>
<td>77</td>
<td>528 - 543</td>
<td>48</td>
<td>62 - 78</td>
<td>20</td>
</tr>
<tr>
<td>993 - 1008</td>
<td>76</td>
<td>511 - 527</td>
<td>47</td>
<td>46 - 61</td>
<td>19</td>
</tr>
<tr>
<td>976 - 992</td>
<td>75</td>
<td>494 - 510</td>
<td>46</td>
<td>29 - 45</td>
<td>18</td>
</tr>
<tr>
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<td>74</td>
<td>478 - 493</td>
<td>45</td>
<td>9 - 28</td>
<td>17</td>
</tr>
<tr>
<td>943 - 968</td>
<td>73</td>
<td>461 - 477</td>
<td>44</td>
<td>below 9</td>
<td>16</td>
</tr>
<tr>
<td>926 - 942</td>
<td>72</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
tests were scored on the basis of ten points for every test performed correctly on the first trial, nine points for any test performed correctly on the second trial, eight points for any test performed correctly on the third trial, and so forth (scoring on any one test stops with one successful performance). The resulting validity coefficients are shown in Table IX.

**TABLE IX**

VALIDITY COEFFICIENTS OF THE BRACE TEST AND THE IOWA REVISION OF THE BRACE TEST AS MEASURES OF SPORT-TYPE MOTOR EDUCABILITY FOR COLLEGE MEN

<table>
<thead>
<tr>
<th></th>
<th>One Trial</th>
<th>Two Trials</th>
<th>Ten Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brace Criterion</td>
<td>.2210</td>
<td>.2138</td>
<td>.3083</td>
</tr>
<tr>
<td>Iowa-Brace</td>
<td>.3375</td>
<td>.2715</td>
<td>.2345</td>
</tr>
<tr>
<td>Brace Iowa-Brace</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following statements are brought to the readers' attention at this point:

1. All correlations between the Brace and Iowa-Brace Batteries and the criterion are positive but low. Apparently, there is a positive relationship between both batteries and sport-type motor educability, but this relationship is too low to classify either test as a measure of sport-type motor educability.

2. Ten trials of Test 21 (Full Turn to Right) or ten trials of Test 26 (Forward Hand Kick) correlate higher with the criterion.
(r_c.21 = .3999, r_c.26 = .3130.) than the entire Brace Battery on one, two, or ten trials.

3. Ten trials of Test 33 (Russian Dance) correlate higher with the criterion (r_c.33 = .3526.) than one, two or ten trials of the entire Iowa-Brace Battery.

4. Apparently, there are certain specific factors which are present in both stunt-type and sport-type learning. This would explain why certain tests in both batteries correlate higher with the criterion than their entire respective batteries. It would explain also the positive correlations between the criterion and the above mentioned batteries.
CHAPTER V

SUMMARY OF THE FINDINGS AND RECOMMENDATIONS FOR FUTURE RESEARCHES

I. FINDINGS PERTINENT TO THE DEDICATION OF THIS THESIS

It was the purpose of this study "(1) to select the battery of tests from an experimental group of 49 tests that would maximally predict sport-type motor educability for male college freshmen, (2) to set up standard scores for the selected battery based on the subjects in this study in the event that a valid battery is constructed, and (3) to determine the validity of the Brace Test and the Iowa-Revision of the Brace Test for Senior High School boys as measures of sport-type motor educability for male college freshmen."

Within the limitations of this study the following findings are reported:

1. The battery that will maximally predict sport-type motor educability for male college freshmen consists of four tests—Test 46 (Short Wall Volley Test), Test 3 (Lie, Throw Tennis Ball-Catch), Test 47 (Short Ball Bounce Test), and Test 45 (Basketball Shooting). This battery has a multiple correlation of .7897 with the criterion.
The multiple regression equation for determining the predicted score in raw score form is:

\[ Y = 7.1744X_{46} + 17.2857X_{3} + 2.7014X_{4} + 19.2265X_{45} \]

2. Two reliability estimates of the battery yield correlation coefficients of .9136 and .8382.

3. A table was constructed to convert raw predicted scores to standard scores with a mean of 50 and a sigma of 10. (This table can be found on page 71 and in the Appendix.)

4. Neither the Brace Battery nor the Iowa-Revision of the Brace Battery for Senior High School Boys are related to the rate of learning sport-type skills to the extent that either could be classified as a test of Sport-Type Motor Educability.

II. NOTEWORTHY FINDINGS AND RECOMMENDATIONS DRAWN FROM THE DATA BUT NOT DIRECTLY RELATED TO THE DEDICATION OF THIS THESIS

For the interest of the reader and within the limitations of this thesis the following findings and recommendations are reported:

1. Students differ greatly in their ability to learn both stunt-type and sport-type motor skills.

2. This study further affirms the theory of a common general factor in sport-type motor learning.

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1 A description of the selected battery with instructions for giving and scoring the tests can also be found in the Appendix.
3. Tests numbered 11 (Walk in a Straight Line), 12 (Jump, Clap Feet Together), 13 (Arms Folded Sit Up), 20 (Kick Right Foot Shoulder), 25 (One Foot-Touch Head), 30 (Grapevine), and 31 (Three Dips) are too easy to be of any value for use with college men. It is recommended that future researchers omit these tests from their respective batteries. Whatever the batteries predict, these tests are too easy to contribute anything to this prediction.

4. Chance is probably a bigger factor in sport-type tests than with the type of tests used by Brace and McCloy. Future researchers using "untried" sport-type tests are cautioned about the number of trials necessary to counter this chance factor. At least twenty trials is recommended for "untried" sport-type tests.

5. Ability to learn sport-type skills and/or stunt-type skills is not dependent upon total strength.

6. Body power is significantly related to about 72 per cent of the tests in the experimental battery. Power appears to be about equally related to both sport-type and stunt-type tests.

7. Although not high enough to be of a predictive value, power is significantly related to the criterion of this study ($r_{op} = .2596$).

8. Apparently, there are certain specific factors which are present in both stunt-type and sport-type learning. This would explain why certain tests in both the Brace and the Iowa-Brace Batteries correlate higher with the criterion than their entire respective batteries. It would explain also the positive correlations (although
all are quite low) between the criterion and the above-mentioned batteries.

9. The long form of the Ball Bounce test alone correlated .7488 with the criterion. If for any reason it were not feasible to give the selected battery, this test is recommended as a possible substitute. Its reliability coefficient was .9508.
SELECTED BIBLIOGRAPHY
A. BOOKS


B. PERIODICAL ARTICLES


———, "Validity of Football Achievement Tests as a Measure of Motor Learning and as a Partial Basis for the Selection of Players," Research Quarterly, 14:372-378, 1943.


C. UNPUBLISHED MATERIALS


APPENDIX
GIVING AND SCORING THE SELECTED BATTERY

**Instructions for giving tests.** No practice trials are given on any of these tests. The very first trial counts. Each test is preceded by an explanation and demonstration. Instructions for scoring each test are given under the description of that test.

**Description of Tests.**

1. **Wall Volley Test.** The subject stands behind a line drawn three feet from a wall and volleys a volleyball above a line drawn on the wall ten and one-half feet above the floor. The volley is started with a two-handed toss against the wall. The number of volleys up to ten is recorded on each of seven trials. The score stops on each trial when (1) ten points have been scored, or (2) the subject steps on or over the restraining line, or (3) a volley does not go above the line drawn on the wall, or (4) a "caught ball" is ruled by the scorer. The two-handed toss starting each volley counts one point. A short rest period follows the fourth trial. The total score for the test is the sum of the scores made on the seven trials.

2. **Lie on Back, Throw Tennis Ball in Air, and Catch.** The subject lies flat on his back, holding a tennis ball. He throws the ball six feet or higher in the air and catches it in either hand while remaining in the "lying on back" position. It is a failure (1) not to throw the ball at least six feet in the air, and/or (2) not to catch the ball in one hand, and/or (3) not to maintain the "lying on back" position during the entire procedure. The instructor should get a student about six feet in height to stand alongside the subject being tested and instruct the subject to throw the ball well above the standing student's head. This gives the subject an idea of how high he must throw the ball and the instructor an objective basis for scoring. The total score is the number of successful attempts in ten trials.

3. **Ball Bounce Test.** The subject stands in the middle of a circle six feet in diameter holding a medium weight softball bat one hand's length from the heavy end. The subject attempts to bounce a volleyball on the top of the bat (not on the side, but on the very top of the bat). The number of bounces up to ten is
recorded on each of ten trials. The score stops on each trial when (1) ten points have been scored, or (2) the subject steps on or over the line bounding the six foot circle, or (3) the ball hits the subject's body, or (4) the ball does not go six inches above the end of the bat. The total score for this test is the sum of the scores made on the ten trials.

4. Basketball Shooting. The subject takes twenty shots from the free throw line (any method or combination of methods). The score is the number of successful attempts in twenty trials.

Determining the Predicted Score. The multiple regression equation for predicting the criterion \( X_c \) in raw score form is:

\[
\bar{X}_c = 7.1744X_1 + 17.2857X_2 + 2.7014X_3 + 19.2265X_4
\]

To predict the criterion score for any one subject, substitute his total raw scores for Tests 1, 2, 3, and 4 in the above regression equation. Substitute the total score on Test 1 (Wall Tolley) for \( X_1 \), the total score for Test 2 (Lie on Back, Throw Tennis Ball in Air and Catch) for \( X_2 \), and so forth. The resulting predicted score \( \bar{X}_c \) has a validity coefficient of .7897.

Predicted scores can readily be converted to meaningful standard scores with the use of Table VIII.
## TABLE VIII

CONVERSION OF RAW SCORES (R) TO STANDARD SCORES (S)

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VITA

The author was born November 6, 1927, in New Orleans, Louisiana. He received his elementary and secondary education in New Orleans at the Sacred Heart Elementary School and Jesuit High School respectively.

In June, 1944, he enrolled at Louisiana State University, where he studied until he was inducted in the United States Armed Forces in 1946. Having been honorably discharged in June, 1947, he enrolled again at Louisiana State University for the fall semester of 1947. He was graduated in June, 1949, with a major in Health and Physical Education and a minor in Mathematics.

In September, 1949, he enrolled in the Graduate School of Louisiana State University. During the school year of 1949-50, he taught as a graduate assistant in the Department of Health and Physical Education. In June, 1950, he received his M. S. degree with a major in Physical Education.

In September, 1950, he began work on his Doctor of Philosophy degree, majoring in Physical Education and minoring in Education. During the school year of 1950-51, he again taught as a graduate assistant in the Department of Health and Physical Education. He was recalled into active duty in May, 1951; honorably released in August, 1952, and enrolled again at Louisiana State University in September, 1952.
On June 10, 1950, the author married Martha Jane Powell of Birmingham, Alabama. He has two children—Carol Jane Adams, born February 18, 1952, and David Arthur Adams, born February 23, 1954. Since September, 1952, the family has resided in Baton Rouge, where the writer is presently a candidate for the degree of Doctor of Philosophy, and is teaching as a graduate assistant in the Department of Health and Physical Education.
EXAMINATION AND THESIS REPORT

Candidate: Arthur R. Adams

Major Field: Physical Education

Title of Thesis: A Test Construction Study of Sport-Type Motor Educability for College Men

Approved:

[Signatures]

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination:

5/3/54