A FACTORAL COMPARISON OF THE IOWA-BRACE MOTOR EDUCABILITY TEST AND A TEST OF GENERAL MENTAL ABILITY

by

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B.Sc., Dalhousie University, 1966

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

Master of Physical Education
in the School of Physical Education and Recreation

We accept this thesis as conforming to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA
July, 1968
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Department of Physical Education

The University of British Columbia
Vancouver 8, Canada

Date August 17, 1977
ABSTRACT

The California Test of Mental Maturity - Long Form Level 2 and the Iowa-Brace Test of Motor Educability were administered to 112 girls from grade five classes in seven randomly selected city schools of Vancouver, British Columbia.

The scores obtained on both tests were slightly higher than those expected in the normal population.

A small positive relationship (0.30) was found between total Iowa-Brace scores and total IQ. The correlation of the Non-Language Section IQ of the California Test of Mental Maturity with Iowa-Brace total score was significantly (0.02) higher than that obtained when the Language section IQ was correlated with total Iowa-Brace.

Principal component analysis of the Iowa-Brace Test isolated five factors accounting for 67 per cent of the test variance. Only one of these factors showed any relationship to the five factors of the California Test of Mental Maturity. Factor V showed low positive correlations with the Logical Reasoning and Spatial Relations factors.

No practically useful relationship seems to exist between the Iowa-Brace Motor Educability Test and the California Test of Mental Maturity.
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ACKNOWLEDGEMENTS

The writer would like to express her appreciation to Dr. S.R. Brown for his invaluable assistance in the preparation of this manuscript.

Without the co-operation of Dr. Norman Ellis of the Vancouver School Board and the principals and teachers of the schools participating, this study could not have been undertaken.

The assistance given by Miss Helen Klassen, Miss Antoinett Van Berkel and others during testing sessions is greatly appreciated.
CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

Studies showing specificity in the learning and retention of motor skills have cast doubt on the existence of a general motor educability construct.¹ Yet, many physical educators still feel that such a capacity exists to a greater or lesser degree in all of their students. There is some evidence in the literature to suggest that the Iowa-Brace Test of Motor Educability can be used to predict achievement in the early stages of learning a motor skill.² Factor analytic studies of the early stages of the motor learning process show a considerable amount of variance accounted for by "non-motor" factors such as those measured by tests of general mental ability.³

I. THE PROBLEM

Statement of the problem. The purpose of this study is to compare the factorial structures of the Iowa-Brace Test of Motor Educability and the California Test of Mental Maturity -- Long Form (a general mental ability test).

Significance of the problem. The Iowa-Brace Test of Motor Educability has a low reliability (0.6111 ± 0.0320 using equivalent halves) and only moderately high positive correlations are found between this test and the level of
skill achieved in new motor tasks.\textsuperscript{4} (See Table I) For these reasons its usefulness as a predictor of ability to learn a motor skill is questionable. The Iowa-Brace Test of Motor Educability and other stunt-type motor educability tests are rarely used in physical education classes or research today. Investigators in other fields sometimes use these tests without realizing that modern motor learning research has led to doubt in their validity.

Research designs which require equivalent groups so that the effects of several different treatments can be evaluated are common in physical education research. No reliable measure of ability to learn motor skills is available and so researchers substitute intelligence tests or school achievement. The use of intelligence tests can only be justified if those used have subtests loading heavily on some of the factors identified as playing roles in the learning of a new motor skill; such as spatial relations, perceptual speed, visualization and mechanical analysis.\textsuperscript{5} The use of intelligence tests to group children into physical education classes is administratively convenient since most schools are already using an intelligence testing program for grouping in academic subject areas and separate testing for physical education consumes valuable teaching time.

When motor educability tests were first introduced studies were conducted which showed no relationship between
<table>
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<th>Basketball</th>
<th>Volleyball</th>
<th>Baseball</th>
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<td>1. Initial Achievement</td>
<td>.3117 ± .1113</td>
<td>.3004 ± .0647</td>
<td>.3392 ± .0770</td>
</tr>
<tr>
<td>2. Final Achievement</td>
<td>.5371 ± .0872</td>
<td>.2949 ± .0647</td>
<td>.2834 ± .0802</td>
</tr>
<tr>
<td>Difference (2-1)</td>
<td>.1219 ± .1214</td>
<td>-.0305 ± .0711</td>
<td>.1054 ± .0860</td>
</tr>
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</table>

motor educability test results and those of intelligence tests. Now researchers are using intelligence tests to serve the same purpose motor educability tests were originally designed to serve. It therefore becomes important to re-examine the relationship between these two types of tests.

Delimitations. Different forms of the Iowa-Brace Test are used for boys and girls. It was decided to test only girls so that testing sessions would require only one examiner and would take up as little school time as possible.

Level two of the California Test of Mental Maturity is designed for use in grades four, five and six. By selecting the sample from grade five it was hoped to reduce the number of students whose ages were outside the normal range for level two of the California Test of Mental Maturity. There are three levels of the Iowa-Brace Motor Educability Test, one for elementary school children, one for junior high school children, and one for senior high school children. A sample composed of grade five girls was expected to fall well within the age range suitable to the elementary form of the Iowa-Brace Test of Motor Educability.

Limitations. In spite of the fact that the sample was restricted to grade five girls, nearly one quarter of the subjects were eighteen months or more beyond their tenth birthday. Although the California Test of Mental Maturity has tables for students up to thirteen years of age the
Iowa-Brace Test is not similarly adjusted to correct for age. Scores on the Iowa-Brace Test, like those of the early intelligence tests after which it is patterned, gradually increase with age. For this reason spuriously high scores were obtained on the elementary level of the Iowa-Brace Test by the girls more than eighteen months beyond their tenth birthday. It was impossible in the time allowed in the schools to test enough subjects to form a sample of girls all within eighteen months of their tenth birthday.

II. DEFINITION OF TERMS USED

**Motor educability** -- Aileen Carpenter: "The readiness with which an individual learns a new motor skill."  

-- Bryant Cratty: "Motor educability may be defined as the capacity to learn [a motor skill]."  

-- C.H. McCloy: "The ability to learn motor skills easily and well."  

**Factor** -- a hypothetical construct underlying some measureable variable.
REFERENCES


4Gire and Espenschade, loc. cit.

5Cratty, op. cit., p. 261.


8Cratty, op. cit., p. 11.

9McCloy, op. cit., p. 84.

CHAPTER II

REVIEW OF THE LITERATURE

**Motor educability:** C. H. McCloy listed several factors generally accepted to be prerequisite to the successful learning of the types of motor skills taught in physical education classes. McCloy's list includes: (1) muscular strength, (2) dynamic energy, (3) ability to change direction, (4) flexibility, (5) agility, (6) lack of an undue amount of excess fat or "dead" weight.  

Another group of factors has been identified which enters into the learning of various motor skills. In the learning of any one skill not all of the factors are operative. According to McCloy these were the factors inherent in motor educability: (1) insight into the nature of the skill, (2) depth perception, (3) general kinesthetic sensitivity and control, (4) balance, (5) perceptual speed, (6) ability to visualize spatial relationships, (7) sensory-motor co-ordination I (eye-hand, eye-foot), (8) sensory-motor co-ordination II (adaptation to external forces), (9) judgement concerning time, height, distance, direction, (10) co-ordination for complicated unitary movement (as in diving), (11) co-ordination for a combination of movements, (12) arm control, (13) accuracy of direction, (14) sensory rhythm, (15) timing, (16) motor rhythm, (17) quick and
adaptive decisions, (18) aesthetic feelings. McCloy identified some of these factors by factor analytic studies of tests purporting to measure motor educability and others by subjective observation.

The Iowa Revision of the Brace Test of Motor Ability was developed by C.H. McCloy in the early thirties. He used the Stanford-Binet Intelligence Test as a model for his test of "motor educability." Of the forty stunts in the Brace test twenty-one were selected for use in the Iowa Revision of the test. Only stunts having low correlations with measures of strength, size and maturity, and power were included in the Iowa-Brace test. This test was designed so that scores increased with the age of the subject.

A study by Eugenia Gire and Anna Espenschade determined the reliability of the Iowa-Brace Test, using equivalent halves. The reliability coefficient was 0.6111 ± 0.0320 which is lower than that of the longer Brace Test. Achievement in the early stages of learning several motor skills associated with common sports correlated quite highly with the Iowa-Brace Test. (See Table I, page 3.)

A factor analysis of the Iowa-Brace Test of Motor Educability was performed by Ester Cope. She identified six factors: (1) dynamic energy, (2) flexibility, (3) balance, (4) horizontal semi-circular canal balance, (5) "insight", (6) arm co-ordination. The subjects in this study were high school girls ranging in age from eleven to
eighteen. Several tests were included in the factor analysis beside the Iowa-Brace test. These included the Sargent Jump, Physical Fitness Index and tests of balance, flexibility, and rhythm. Junior high school girls are normally tested on a slightly different set of stunts than those used for high school girls. Since the Iowa-Brace test was specifically designed to yield increasingly higher scores with increases in age, the use of one set of stunts for a sample of such great age range appears to be a weakness of this study. No evidence of the reliability or validity of the tests of flexibility, balance or rhythm was given.

McCloy reported that he found no relationship between measures of intelligence and measures of motor educability. McCloy's observation that there was no relationship between his test of motor educability and general intelligence appears to be based on studies of college students. College age students often have prefixed negative ideas about their ability to perform motor tasks and about the importance of such tasks. Attitudes such as these could affect the level of performance on the Iowa-Brace Test and might obscure any relationship between it and intelligence.

Cecille Meserve found a correlation of 0.318 between the Brace Motor Ability Test and I.Q. as measured by the Otis and Stanford-Binet Intelligence Tests in a sample of "normal boys." Vickers et al found a significant positive
correlation between the Brace Scale and the upper and lower ranges of intelligence in a sample of children ages five to nine. 9 Using college age subjects Johnson failed to find any relationship between his test of motor educability and scores on the American Council of Education Intelligence Test. 10 Several studies of mentally retarded children have found a positive relationship between measures of intelligence and the Iowa-Brace Motor Educability Test. 11

Intelligence testing. In the period of time since the studies in the preceding section were completed the method of scoring intelligence tests has changed. In the old method an "intelligence quotient" was obtained by dividing the mental age derived from test scores by chronological age. Using this method "IQ" increased up to about age fifteen and then leveled off. Modern tests of intelligence give "IQ equivalents" based on the normal curve. These scores are relatively constant for one individual throughout life. 12 No such consistency throughout life is found for motor educability scores because motor educability tests were modelled after the old intelligence tests. Had modern methods of calculating general mental ability scores been used in the studies listed above, the results might well have been different.

Motor learning research. Recent studies in motor learning have found that there is a great deal of specificity
in the learning of motor skills. This discovery has cast doubt on the existence of general motor educability. However, there is some evidence to suggest that the early stages of learning a motor skill are not task-specific. Edwin Fleishman found that in the early stages of learning general factors such as psychomotor co-ordination, spatial relations, visualization, mechanical experience, and perceptual speed accounted for most of the variance in test scores. In the later stages of practice psychomotor co-ordination, rate of movement and a factor peculiar to the criterion task accounted for most of the variance in the scores. (See Figure 1, page 12.) Fleishman found that 46.1 per cent of the early variance in test scores was accounted for by "non-motor" factors, while only 29.5 per cent was accounted for by motor factors. Late in the learning process 10.5 per cent of the variance was accounted for by "non-motor" factors and 74.5 per cent by motor factors. The importance of non-motor factors in the initial stages of learning agrees with the evidence that verbalization and mental practice facilitate the learning of a motor skill in the initial stages.
FIGURE 1

PERCENTAGE OF VARIANCE REPRESENTED BY EACH FACTOR AT DIFFERENT STAGES OF PRACTICE ON THE COMPLEX CO-ORDINATION TEST

REFERENCES


2 Ibid., p. 5-10.


7 McCloy, op. cit., p. 83.


16 Fleishman, op. cit., p. 251.

CHAPTER III

METHODS

Sample. The sample consisted of 112 grade five girls from city schools of Vancouver, British Columbia. Seven classes were randomly selected from the Directory of Teaching Staff by Schools. All grade five classes were numbered consecutively and a random number table was used to select seven of the classes for use in the study.1

Testing procedures. All classes were tested within a three week period at the end of May. The language section of the California Test of Mental Maturity -- Long Form was administered during the morning. The language section was very long and therefore a two minute break was given following test seven before the last half hour of testing. The Iowa-Brace test was administered first in the afternoon and was followed by the non-language section of the California Test of Mental Maturity. Standardized instructions prescribed for each test were followed exactly.2 The examiner did all of the marking for the Iowa-Brace Test. The California Test of Mental Maturity was scored using hand scoring stencils. Tables provided in the Examiner's Manual were used to convert raw scores to percentiles in the case of the factors and deviation IQ's in the case of Language, Non-Language and Total IQ. Scores on the Iowa-
Brace Test were left in the raw score form because the norms for this test were established so long ago that their present usefulness is questionable.

The Iowa-Brace Test consisted of ten stunts prescribed for use with elementary school girls by C.H. McCloy. Descriptions of these stunts are to be found in Appendix A. Details of the development of this test and of its reliability and validity have already been discussed in the Review of the Literature.

The California Test of Mental Maturity — Long Form was selected for use in this study for several reasons. The Iowa-Brace Test of Motor Educability was patterned after the Stanford-Binet Intelligence Test. The California Test of Mental Maturity was scaled to give the same results as the Stanford-Binet Intelligence Test and correlates .99 with it. The California Test of Mental Maturity has been factor analyzed and five factors have been identified definitely: (1) Logical reasoning, (2) Numerical reasoning, (3) Spatial relations, (4) Memory, (5) Verbal concepts. The format of the test is such that scores on these factors are easily obtained. The California Test of Mental Maturity — Long Form is commonly used in the schools, and detailed information about its reliability and validity is readily available. Reliability coefficients are to be found in Appendix B.
Method of analysis. The distribution of pupils' scores on the California Test of Mental Maturity and on the Iowa-Brace test were plotted separately and the mean, standard deviation and standard error of each distribution were calculated.

The total scores on the Iowa-Brace Test were correlated with the total score on the California Test of Mental Maturity. The Iowa-Brace total scores were also correlated with the Language and Non-Language IQ scores. The significance of the difference between the correlation coefficients for Language and Non-Language was calculated.

A principal component analysis of the matrix of triserial correlation coefficients for the stunts in the Iowa-Brace Test of Motor Educability was made. It was necessary to use triserial correlation coefficients because only three possible scores can be obtained on an item of the Iowa-Brace Test. \[ 0 \text{ (failed 2 trials)}, 1 \text{ (failed trial 1 but passed trial 2)}, \text{ or } 2 \text{ (passed on first trial)} \]. Five factors were isolated accounting for 67 per cent of the total variance of the test. These five factors were compared with the five factors of the California Test of Mental Maturity in a correlation matrix.
REFERENCES


5 Technical Report, op. cit.
CHAPTER IV

RESULTS AND DISCUSSION

I. PRESENTATION OF DATA

Sample distributions. The distributions of both the Iowa-Brace Test and the California Test of Mental Maturity (Figures 2, 3) are slightly negatively skewed. Since both distributions deviate from the normal curve in the same direction their skewness does not prohibit the use of correlation coefficients.

Pupils' scores on the California Test of Mental Maturity range from 61 to 134. The mean score for this sample is 105.0 and the standard deviation is 15.39. The standard error of measurement is 3.078. The standard error was calculated using the KR21 correlation coefficient given for this level of the test in the Technical Report. This test was designed to have a mean of 100.0, standard deviation of 16 for the total population. The standard error in the population is 3.5.\(^1\)

The range of scores made by pupils on the Iowa-Brace Test of Motor Educability is from 1 to 17. The mean score is 9.14 and the standard deviation is 3.44. The standard error of measurement obtained by Eugenia Gire using equivalent halves correlation coefficient (0.6111) was 2.15.\(^2\)
Range - 73
Mean - 105.0
S.D. - 15.39
S.E. - 3.078

FIGURE 2

DISTRIBUTION OF TOTAL I.Q. FOR 112 GRADE FIVE GIRLS
Range = 16
Mean = 9.143
S.D. = 3.440
S.E. = 2.150

FIGURE 3
DISTRIBUTION OF TOTAL SCORE ON IOWA-BRACE TEST FOR 112 GRADE FIVE GIRLS
The Iowa-Brace Test lacks discrimination in this sample as demonstrated by the fact that the standard error is two thirds as large as the standard deviation.

**Correlation.** The total score on the Iowa-Brace Test was correlated with the three IQ scores - Language, Non-Language and Total using Pearson product-moment correlation coefficients (see Table II). Using a "t-test" of significance these correlations were all found to be significantly different from zero at the 0.05 level. The difference between the correlation of the total Iowa-Brace scores with Language IQ (r_{12}) and the correlation of the Total Iowa-Brace scores with the Non-Language IQ scores (r_{13}) was tested for significance. The difference is 0.1756. The standard error of the difference is 0.0862. The $z$ ratio is 2.037 and is significant at the 0.02 level.\(^3\)

$$
\sigma_{dr} = \sqrt{\sigma_{r_{12}}^2 + \sigma_{r_{13}}^2 - 2r_{12}r_{13} \sigma_{r_{12}} \sigma_{r_{13}}}
$$

$$
= \sqrt{(0.0911)^2 + (0.0831)^2 - 2(0.5746 \times 0.0911 \times 0.0831)}
$$

$$
= 0.0862
$$

$$
\bar{z} = \frac{r_{13} - r_{12}}{\sigma_{dr}}
$$

When 1 = Total Iowa-Brace

2 = Language IQ

3 = Non-Language IQ

$$
= \frac{0.1756}{0.0862}
$$

$$
= 2.037
$$
**TABLE II**

PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENTS
FOR IOWA- BRACE SCORES AND CALIFORNIA TEST
OF MENTAL MATURITY I.Q. SCORES

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<tbody>
<tr>
<td>1. Total Iowa-Brace</td>
<td>.18</td>
<td>.35</td>
<td>.30</td>
<td>1.00</td>
</tr>
<tr>
<td>2. Language I.Q.</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Non-Language I.Q.</td>
<td>.72</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.90</td>
<td>.95</td>
<td>1.00</td>
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The difference between these two correlations is significant beyond the 0.05 level which would have been acceptable in this study. The Non-Language section of the California Test of Mental Maturity seems to account for most of the relationship between the California Test of Mental Maturity and the Iowa-Brace Test. The scatter plot showing the relationship between these two tests is more rectangular than elliptical and shows a small, but definitely positive relationship.

**Principal component analysis.** A correlation matrix for the stunts composing the Iowa-Brace Test was prepared using triserial correlation coefficients. Principal component analysis was used on the correlation matrix and five factors were isolated, accounting for 67 per cent of the total test variance. The factor matrix was rotated by the varimax method of rotation to give the final factor structure. Table III gives the rotated factor matrix and the unrotated factor matrix is given in Appendix C.

Scores on the five factors of the Iowa-Brace test were computed for each subject and correlated with scores on the five factors of the California Test of Mental Maturity. Table IV shows the correlations between the two sets of factors.
FIGURE 4
SCATTER PLOT OF TOTAL IOWA-BRACE AND TOTAL I.Q.
**TABLE III**

**ROTATED FACTOR MATRIX FOR IOWA-BRACE MOTOR EDUCABILITY TEST**

<table>
<thead>
<tr>
<th>Factors</th>
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<th>IV</th>
<th>V</th>
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<tbody>
<tr>
<td>1. Hop Backward</td>
<td>0.07301</td>
<td>0.03727</td>
<td>0.90514</td>
<td>-0.09539</td>
<td>0.01606</td>
</tr>
<tr>
<td>2. Full Right Turn</td>
<td>0.08202</td>
<td>0.51602</td>
<td>0.11853</td>
<td>-0.39314</td>
<td>-0.06779</td>
</tr>
<tr>
<td>3. Full Left Turn</td>
<td>-0.01375</td>
<td>0.01117</td>
<td>0.04208</td>
<td>-0.92041</td>
<td>0.02560</td>
</tr>
<tr>
<td>4. The Top</td>
<td>0.14466</td>
<td>-0.04179</td>
<td>-0.15778</td>
<td>-0.12896</td>
<td>0.82922</td>
</tr>
<tr>
<td>5. Forward Hand Kick</td>
<td>0.45619</td>
<td>0.36503</td>
<td>-0.32704</td>
<td>-0.25953</td>
<td>0.11465</td>
</tr>
<tr>
<td>6. One Foot - Touch Head</td>
<td>0.01656</td>
<td>0.82817</td>
<td>-0.04704</td>
<td>0.20532</td>
<td>-0.02982</td>
</tr>
<tr>
<td>7. Grapevine</td>
<td>-0.18252</td>
<td>0.22666</td>
<td>0.32318</td>
<td>0.22651</td>
<td>0.64327</td>
</tr>
<tr>
<td>8. Kneel, Jump to Feet</td>
<td>0.17642</td>
<td>0.61824</td>
<td>0.03362</td>
<td>-0.17918</td>
<td>0.30072</td>
</tr>
<tr>
<td>9. Side Kick</td>
<td>0.73002</td>
<td>0.25956</td>
<td>-0.12767</td>
<td>0.03846</td>
<td>0.11614</td>
</tr>
<tr>
<td>10. Double Heel Click</td>
<td>0.79979</td>
<td>-0.10892</td>
<td>0.30206</td>
<td>-0.01122</td>
<td>-0.10142</td>
</tr>
</tbody>
</table>
TABLE IV.

CORRELATION BETWEEN FACTORS OF IOWA-BRACE TEST AND FACTORS OF CALIFORNIA TEST OF MENTAL MATURITY LONG FORM

<table>
<thead>
<tr>
<th>Factors of Iowa-Brace Test</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logical Reasoning</td>
<td>0.1629</td>
<td>0.1141</td>
<td>0.1075</td>
<td>-0.1565</td>
<td>0.2859</td>
</tr>
<tr>
<td>Spatial Relationships</td>
<td>0.0808</td>
<td>0.0973</td>
<td>-0.1358</td>
<td>-0.2411</td>
<td>0.3035</td>
</tr>
<tr>
<td>Numerical Reasoning</td>
<td>0.2060</td>
<td>0.1431</td>
<td>-0.0756</td>
<td>-0.1716</td>
<td>0.1042</td>
</tr>
<tr>
<td>Verbal Concepts</td>
<td>0.1583</td>
<td>0.0282</td>
<td>-0.1333</td>
<td>-0.0477</td>
<td>0.1107</td>
</tr>
<tr>
<td>Memory</td>
<td>0.0871</td>
<td>0.0480</td>
<td>0.0935</td>
<td>-0.0652</td>
<td>-0.0145</td>
</tr>
</tbody>
</table>
II. DISCUSSION

There is a small positive relationship between the Iowa-Brace Test of Motor Educability and the California Test of Mental Maturity. The Non-Language section of the California Test of Mental Maturity has a significantly higher relationship to the Iowa-Brace Test than the Language section does.

Principal component analysis of the correlation matrix of the stunts composing the Iowa-Brace Test identifies five factors accounting for 67 per cent of the variance of the test. The large number of factors in proportion to the number of variables required to account for 67 per cent of the test variance indicates that the factors of this test have very low intercorrelations and are quite distinct.

Double heel click, side kick and forward hand kick load most heavily on Factor I. This factor seems to correspond with Factor III identified by Ester Cope. She called this factor a balance factor inspite of its very low weighting on a test of balance. This factor appears to be better described as a timing factor.

One foot touch head, kneel jump to feet, and full right turn weight most heavily on Factor II. This factor does not correspond to any of Ester Cope's factors. It seems to be the ability to use the arms to assist the execution of rapid body movement. This hypothesis is supported by the fact that the forward hand kick also loads
slightly on this factor. The top has a negative weighting on this factor. In this stunt the arms cannot be used because the subject must hold his ankles throughout the stunt.

The hop backward stunt has a very high positive loading on Factor III. No real attempt to identify this factor can be made on this basis. Similarly full left turn weights very heavily on Factor IV.

The top and grapevine weight heavily on Factor V. Kneel jump to feet loads slightly on this factor. This is the only factor of the Iowa-Brace Test that shows any correlation with factors of the California Test of Mental Maturity. Low positive correlations are found between this factor and the Spatial Relations and Logical Reasoning factors of the California Test of Mental Maturity. Factor V appears to be an insight or understanding into tasks.
REFERENCES


CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

I. SUMMARY

The California Test of Mental Maturity - Long Form Level 2 and the Iowa-Brace Test of Motor Educability were given to 112 grade five girls. The correlations between total Iowa-Brace scores and total IQ, Language IQ, and Non-Language IQ were calculated. A principal component analysis was made of the correlation matrix of the Iowa-Brace Test. The factors obtained for the Iowa-Brace Test were correlated with the factors of the California Test of Mental Maturity.

II. CONCLUSIONS

There is a small positive relationship between the Iowa-Brace Test of Motor Educability and the California Test of Mental Maturity -- Long Form. This relationship is almost entirely accounted for by the correlation between the Non-Language section of the California Test of Mental Maturity and the Iowa-Brace Test. This would seem to suggest that when intelligence tests are to be used to facilitate homogenous grouping in physical education classes or to establish equivalent groups for research, only tests with substantial non-language content should be used. This suggestion should be tested directly before it is put into practice.
The factors of the two tests are not related except for Factor V of the Iowa-Brace Test which has low, positive correlations with the Logical Reasoning and Spatial Relations factors of the California Test of Mental Maturity.

The five factors of the Iowa-Brace Test account for only 67 per cent of the variance of the test. They have low intercorrelations and appear to be relatively specific to one or two stunts in most cases. This, coupled with the problems associated with the high standard error of measurement, creates great doubt about the usefulness of this instrument for predicting ability to learn a motor skill.

The low positive correlation of the Non-Language section of the California Test of Mental Maturity with performance on the motor tasks included in the Iowa-Brace Test suggests that further study of the relationship between this section and the learning of a wide variety of motor skills might be made. The low positive correlations of Logical Reasoning and Spatial relations factors of the California Test of Mental Maturity with Factor V of the Iowa-Brace Test, suggests that these intelligence factors may play an important role in the early stages of learning and that they might be useful as predictors of success in learning a motor task. This concept is supported by Fleishman's study.¹
III. RECOMMENDATION

It is recommended that further study be made of the relationship between the learning of a wide variety of motor skills and non-language factors of general intelligence along the lines of Bryant Cratty's "Three Layer Theory of Motor Learning."

The results of the above recommendation could be used to develop a test to measure vocational aptitude for jobs requiring the mastery of a motor skill. This test might have a core of non-language intelligence test items and be supplemented by some motor items of skills very similar to those involved in the job task itself.
REFERENCES


"Directory of Teaching Staff by Schools." Vancouver: Board of School Trustees District #39, October, 1967.


Milne, F.T. et al. "Does a Physiological Correlation Exist Between Basic Intelligence and Physical Efficiency of School Children?" Journal of Genetic Psychology, 63, pp. 131-140; 1943.


APPENDIX
APPENDIX A

IOWA REVISION OF BRACE TEST OF MOTOR EDUCABILITY

1. HOP BACKWARD. Stand on either foot. Close the eyes and take five hops backward. It is a failure:
   a. To open the eyes.
   b. To drop the other foot.

2. FULL RIGHT TURN. 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:
   a. Not to make a full turn and to land facing in the same direction as at the start.
   b. To lose the balance and have to step about to keep from falling.

3. FULL LEFT TURN. 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:
   a. Not to turn all the way around.
   b. To move the feet after they strike the floor.

4. THE TOP. Sit down; put the arms between the legs and
under and behind the knees; grasp the ankles; roll rapidly around to the right with the weight first over the right knee, then the right shoulder, then on the back, then left shoulder, then left knee; then sit up facing in the opposite direction from that in which you started. Repeat from this position and finish facing in the same direction from which you started. It is a failure:

a. To let go of the ankles.

b. Not to complete the circle.

5. **FORWARD HAND KICK.** 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:

a. Not to touch both feet while in the air.

b. To bend the knees more than 45 degrees.

6. **ONE FOOT - TOUCH HEAD.** Stand on 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 balance. It is a failure:

a. Not to touch head to the floor.

b. Losing the balance and having to touch the
right foot down or step about.

7. GRAPEVINE. 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. Hold this position for five seconds. It is a failure:
   a. To fall over.
   b. Not to touch and hold the fingers of both hands together.
   c. Not to hold the position five seconds.

8. KNEEL, JUMP TO FEET. 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:
   a. To have the toes curled under and rock back on them.
   b. Not to execute the jump, and not to stand still on both feet.

9. SIDE KICK. 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:
a. Not to swing the feet enough to the side.
b. Not to strike the feet together in the air.
c. Not to land with the feet apart.

10. DOUBLE HEEL CLICK. Jump into the air and clap feet together twice and land feet apart (any distance). It is a failure:

a. Not to clap the feet together twice.
b. To land with feet touching each other.
APPENDIX B

RELIABILITY COEFFICIENTS

CALIFORNIA TEST OF MENTAL MATURITY - LONG FORM

1. LOGICAL REASONING       .83
2. SPATIAL RELATIONSHIPS     .90
3. NUMERICAL REASONING       .94
4. VERBAL CONCEPTS           .94
5. MEMORY                    .84

LANGUAGE I.Q.                .95
NON-LANGUAGE I.Q.            .93
TOTAL I.Q.                   .96
### APPENDIX C

#### UNROTATED FACTOR MATRIX

<table>
<thead>
<tr>
<th>Activity</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hop Backward</td>
<td>0.08862</td>
<td>-0.13310</td>
<td>0.88310</td>
<td>0.12331</td>
<td>-0.12134</td>
</tr>
<tr>
<td>2. Full Right Turn</td>
<td>0.49793</td>
<td>-0.08802</td>
<td>0.12126</td>
<td>-0.26841</td>
<td>-0.32215</td>
</tr>
<tr>
<td>3. Full Left Turn</td>
<td>0.27287</td>
<td>-0.38702</td>
<td>0.17531</td>
<td>-0.76667</td>
<td>0.08453</td>
</tr>
<tr>
<td>4. The Top</td>
<td>0.36420</td>
<td>0.34645</td>
<td>0.00788</td>
<td>-0.13886</td>
<td>0.69166</td>
</tr>
<tr>
<td>5. Forward Hand Kick</td>
<td>0.62890</td>
<td>-0.15027</td>
<td>-0.31970</td>
<td>-0.06030</td>
<td>0.06988</td>
</tr>
<tr>
<td>6. One Foot - Touch Head</td>
<td>0.52299</td>
<td>0.36233</td>
<td>-0.12749</td>
<td>0.15333</td>
<td>-0.53557</td>
</tr>
<tr>
<td>7. Grapevine</td>
<td>0.19983</td>
<td>0.63909</td>
<td>0.40298</td>
<td>0.08765</td>
<td>0.18919</td>
</tr>
<tr>
<td>8. Kneel, Jump to Feet</td>
<td>0.68370</td>
<td>0.21486</td>
<td>0.06293</td>
<td>-0.09485</td>
<td>-0.10221</td>
</tr>
<tr>
<td>9. Side Kick</td>
<td>0.62060</td>
<td>-0.22454</td>
<td>-0.18702</td>
<td>0.36781</td>
<td>0.16049</td>
</tr>
<tr>
<td>10. Double Heel Kick</td>
<td>0.33800</td>
<td>-0.57970</td>
<td>0.20975</td>
<td>0.47130</td>
<td>0.19175</td>
</tr>
</tbody>
</table>