A Comparison of Dynamic Equilibrium of Three Selected Ethnic Groups in the United States

James William Doyle

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A COMPARISON OF DYNAMIC EQUILIBRIUM OF THREE SELECTED
ETHNIC GROUPS IN THE UNITED STATES

James W. Doyle, Master of Science

The thesis here abstracted was written under the direction of
John L. Quaday and approved by Walter C. Koenig and Alton J. Bjork as
members of the examining committee, of which Dr. Quaday was chairman.

Thirty male high school students were tested in an attempt to
determine whether there were any significant differences in dynamic
balance among selected American Negroes, American Indians and American
Caucasians.

Subjects selected were seventeen years of age or older, with
good eyesight and hearing, and with varied backgrounds in sports skills.

The Bass Test of Dynamic Balance was used as the instrument to
measure dynamic equilibrium. The t test was used to test the null hypo­
thesis, and the .01 level of significance was established as the criterion.
The Indian subjects were tested during the summer of 1961, the Negroes in
the fall of 1961, and the Caucasians during the spring of 1962. Each
subject was allowed to practice the Bass Test twice, three trials were
permitted and the average served as the performance score.

The comparison of whites with Indians revealed no significant
difference in dynamic equilibrium.

The Negro subjects which participated in this study were not
significantly superior to the white subjects at the .01 level of con­
fidence. The mean difference of 7.25 in favor of the Negroes did produce
A t of 2.61 which would have been significant at the .02 level, had this criterion been adopted.

The mean difference of 12.94 in favor of the Negroes over the Indians produced a t of 3.93, which was significant at the .01 level of confidence. Negroes in this experiment were significantly superior to the Indians in dynamic equilibrium as measured by the instruments used in this study.
A COMPARISON OF DYNAMIC EQUILIBRIUM OF THREE SELECTED ETHNIC GROUPS IN THE UNITED STATES

by

James William Doyle

B. S. in Physical Education, Michigan State University 1951

A Thesis
Submitted to the Faculty
of the
Graduate School
of the
University of North Dakota
in partial fulfillment of the requirements
for the Degree of
Master of Science

Grand Forks, North Dakota

July 1962
This thesis submitted by James W. Doyle in partial fulfillment of the requirements for the Degree of Master of Science in the University of North Dakota, is hereby approved by the Committee under whom the work has been done.
ACKNOWLEDGEMENTS

The writer is greatly indebted to the following persons and groups, without whose splendid cooperation this thesis could not have been written.

He is especially grateful to his advisor, Dr. John L. Quacken, Chairman of the Department of Physical Education, for his guidance and counsel.

Further appreciation is extended to Mr. Walter C. Koenig, Associate Professor of Physical Education, for his help in bringing this study to completion. Appreciation is also expressed to the instructors who assisted in the testing, and to the students who made the collection of data for this study possible.

Finally, the author expresses deepest appreciation and thanks to his wife for her understanding and patience during the preparation of this thesis.
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<td></td>
<td>and Levels of Significance of American Indians and American Negroes</td>
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</tbody>
</table>
CHAPTER I

INTRODUCTION

Statement of the Problem The purpose of this study was an attempt to determine whether or not any significant differences existed in dynamic equilibrium among selected American Indians, American Negroes, and American Caucasians.

Relatively few studies have been done in the area of dynamic balance. Also very little has been done to establish age, height, and weight norms. No study was found on a comparison of ethnic groups in the area of equilibrium.

Limitations of Study The groups of subjects that participated in this study acted on a voluntary basis. Each participant was given two practice trials on the Bass Test of Dynamic Balance. The test was then administered three times and the average of the three taken as the score.

The instruments employed to obtain the measurements of dynamic balance were the best obtainable.

This experiment was given in six different locations at three different seasons of the year. Four instructors, on separate occasions, assisted the writer in administering the tests. The experiments were conducted on gym floors, in a fire hall, on an outdoor asphalt handball court, in an Indian Agency office, and on a concrete floor adjacent to
a large gym. Not all of these measurements were taken at the same hour of the day. Any one of these factors, or all, may have affected the results of the experiment.

Delimitations of Study This study covered the statistical treatment of thirty young men, twelve whites, twelve Negroes, and six Indians. These young men, ranging in age from seventeen to nineteen, came from North Dakota, Minnesota, and Florida. These subjects had been varsity letter winners in at least two major sports. The participants possessed normal hearing and sight. All available subjects meeting these requirements were tested.

Definition of Terms

Dynamic Balance Physically, dynamic balance refers to the case of a body whose weight is so distributed that the resultant of the forces is varying from moment to moment. Neuromuscularly, dynamic balance refers to the maintenance of an organized postural orientation under conditions in which the activity pattern of the muscles is continually changing so as to disturb the gross postural orientation and require further muscular activity to reestablish the orientation. Psychologically, dynamic balance refers to the postural orientation of the body when the organism is performing a specified motor activity which involves relatively large motion of all or parts of the body which act to disturb the gross orientation of the organism. Examples are dancing, walking, driving a golf club, playing a violin, firing a gun, and most motor acts in industry and athletics.

Ethnic A word relating to a community of physical and mental traits possessed by the members of a group as a product of their common heredity and cultural tradition, also having or originating from racial, linguistic, and cultural ties with a specific group.


Equilibrium  A word synonymous with balance.

Significance of the Problem  In 1929 Grantland Rice wrote an article for *Collier's Magazine* discussing the relationship of good balance to outstanding achievement in various sports. He noted that Jack Dempsey had to have his weight in good balance in order to throw the proper punch effectively. Rice stressed the advantages of proper balance in the batting techniques of Babe Ruth and Rogers Hornsby. His most startling example was Paul Berlingbach. Berlingbach had been the light heavy weight champion of the world. At twenty six years of age the champion was washed up as a fighter because of an operation on his ear which affected his equilibrium.3

Balance is considered one of the basic elements of motor educability. The Iowa Revision of the Bruce Test is just one example of a motor educability test using a balance measurement.4 McCloy stresses the fact that balance is one of the components of motor educability.5

Recently the newspapers, magazines, and other news gathering media of this country have been displaying the exploits of our astronauts. It seems that dynamic equilibrium plays a major part in the testing program carried on with the astronauts. Life magazine carried an illustration of Scott Carpenter being given a beam walking

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5Ibid.
test of balance, on the aircraft carrier "Intrepid", after orbiting the earth. 6

Mohawk Indians have been working on high constructions for years in New York City. One of their construction jobs was the United Nations Building. St. Mary states "they apparently possess a greater sense of equilibrium than people of other races."7

In attempting to determine the abilities of three ethnic groups in the area of balance, the author deems this study purposeful in that it attempts to evaluate physiological equilibrium among three ethnic groups. In doing this it is the further purpose of the author to offer this paper as a motivational device to further investigation of dynamic balance.


CHAPTER II

RELATED LITERATURE

Chapter II is concerned with a review of literature related to the dynamic balance study. The literature reviewed is intended to be a selection of the more pertinent information in the scope of this paper.

Balance. Jones and Leven in discussing balance indicated that, besides the labyrinth, there are many other structures and factors that affect equilibrium. Some of these are the cerebellum, the balls of the feet, the viscera, the eyes, and heat or cold on the ear.\(^8\)

The components of balance are defined by Travis in the following manner:

Various sensory modalities, vision, audition, kinesthesis, vestibulation, the skin senses, and the visceral senses give in different ways essential information in all postural adjustments. It is impossible adequately to attribute dominance to any one sense field over the others in posturing reactions in view of the necessity for the combination of sensory data from a number of sense fields in this type of sensory-motor adjustment of the body as a whole.\(^9\)

Jones and Leven discuss the control of balance in the following interesting manner:

The mechanism that controls our balance, that keeps us steady when we walk upright, is rather complicated. First there is this gyroscope, this labyrinth situated right next to and continuous

---

\(^8\) Leonard Jones and Eli A. Leven, "Dizziness," Hygma, XXXIII (September, 1945), 623-79.

with the organ of hearing. It is supplied by one branch of the same nerve whose other branch goes to the cochlea, or "snail shell," by which we hear. Inside this little gyroscope are three small canals. They are pitched at different angles. One canal senses motion from front to rear, like a destroyer pitching in a heavy sea. Another canal senses motion from side to side, like a ship rolling or rocking in the trough of waves. The third registers motion that is horizontal, such as being whirled in a Coney Island merry-go-round. Disturbances of motion or position or of heat and cold, or impulses from remote parts of the body, can affect any of these semicircular canals and make the victim dizzy.  

Bass conducted a study of "Analysis of the Components of Tests and Semicircular Canal Function and of Static and Dynamic Balance," She concluded that the eyes were definitely one of the elements of equilibrium.  

In a study of rotary acceleration and balance Travis found that vision played a very important and large part in maintaining man's equilibrium. Travis later found that:  

Both static and dynamic equilibrium are aided greatly when visual cues are present: The finer the visual points of reference the better the performance. There is evidence for assuming the presence of a steadiness factor in balancing skill and in eye-manual coordination.  

Hearing  

In a study of deaf basketball players Massengill is cognizant of the fact that good balance is very important for skill at basketball.  

---

10 Jones and Leven, *Hymia*, XXXI, No. 9, 653-59.  
Evidence of poor equilibrium among the boys in his study is present in certain circumstances.\(^\text{14}\)

Daniels says that a person with normal hearing will hear a watch ticking three feet from his head. When using this test, test one ear at a time by bringing the watch from a distance of about five feet toward the subject's ear.\(^\text{15}\)

On the subject of balance and the deaf, Daniels relates the following discussion:

In a recent conversation with the superintendent of a state school for the deaf, the administrator stated that one of the common difficulties experienced by the boys in his school was the matter of balance. This is understandable inasmuch as the auditory organ has the dual function of hearing and equilibrium.\(^\text{16}\)

**Ethnic Differences**

In a measurement with fifty one white and fifty one Negro college students Metheny found that the Negroes' feet were longer and wider than whites in relation to leg length and stature. Negroes were slightly heavier but they had less fat tissue than whites. White students had longer trunks, but shorter arms and legs than the Negroes tested. Negroes were slightly shorter on the average and had less lung capacity than whites. Whites had shorter faces and narrower noses.\(^\text{17}\)

Espenschade conducted a study of fitness on fourth grade children.


\(^{16}\) Ibid.

It was learned that "significantly more Negro boys and both Negro and white girls pass the Krause-Weber test than do white boys." It was learned that "significantly more Negro boys and both Negro and white girls pass the Krause-Weber test than do white boys." 

Hutinger conducted a study of the differences in speed between 390 white boys and girls and 402 Negro boys and girls of the fourth, fifth, and sixth grades in Kansas City.

Conclusions:
The Negro boys had statistically significant faster times in the thirty-five yard dash at the fourth and fifth grade levels while the Negro girls had statistically significant faster times at all three grade levels.

Age, Weight, and Height

In a body sway experiment with naval men, Edwards found that there was no correlation between body sway and height, nor weight, nor age, and very little with body build.

Fisher conducted a study to standardize a railwalking test and an ataxiograph. On a group of unselected men as to age, height, weight and body build, Fisher concluded that there was no significant gain in performance on the rail walking test after the age of seventeen. The group of men ages seventeen to twenty-five had the highest scores.

Bachman tested 160 girls and 160 boys of various ages for two measurements of balance. Their performance indicated that learning

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progressed up to seventeen years of age where a leveling off in learning occurred.22

Espenshade, Deale, and Schoenluke examined 476 adolescent boys with the Seashore Rainbow Test. On the basis of the results obtained in their study, it was ascertained that although there was steady improvement in balance from eleven to sixteen years of age, there was a retarded period or lag from ages thirteen to fifteen. Dynamic balance is closely related to qualities needed to be successful in physical activities, but it is not correlated with height or weight.23

Equilibrium and Athletic Ability

Slater-Harrod, who made an analytical study of twenty-two male varsity athletes, twenty-two male physical education majors, and twenty-two male liberal arts majors on the Reynolds Balance Test, found that athletic ability and good balance were closely related. The results of the experiment showed that the higher the achievement in athletics the better the balance. The varsity athletes had a significantly higher score on the balance test than the physical education majors and the liberal arts majors. The physical education majors scored significantly higher than the liberal arts majors.24

In a study of balance with wrestlers with varying achievement as determined by their position on wrestling squads, Munby was able to


to conclude that good wrestlers had better balance than poor wrestlers.25

Gross and Thompson studied the relationship of dynamic balance
to speed and ability in swimming. On the basis of their study the
following conclusions were drawn:

1. In general, individuals who have better dynamic balance, as deter-
determined by the Bass Test of Dynamic Balance, can swim faster than
individuals who have poor dynamic balance.
2. Individuals with better swimming ability, as determined by
expert judgement, tend to have better dynamic balance than indivi-
duals with poor swimming ability.
3. Dynamic balance, as measured in this study, is not a chance
factor and may be an important factor in speed and ability in
swimming. Further study is needed to determine whether there is
a cause and effect relationship between these factors.26

Other Factors

In a study intended to find a means of objectively
screening Army personnel in motor coordination,
Heath was able to find a useful device in a railwalking test. The
railwalking test proved useful to the Army as a large selecting instru-
ment in finding clumsy and untrainable individuals.27

Travis, in his study of analysis of dynamic and static balance,
found that exercise of a mild form would not affect the outcome of an
individual's score on a test of equilibrium.28

Edwards conducted a study on the excessive loss of sleep on
the body. He was able to conclude that it was difficult to maintain

25H. Hugh Payty, "Kineesthetic Acuity and Balance Related to
Wrestling Ability," Research Quarterly, XXXIV (October, 1953), 327-34.

26Mas A. Gross and Hugh L. Thompson, "Relationship of Dynamic
Balance to Speed and to Ability in Swimming," Research Quarterly, XXVIII
(December, 1957), 326.

27S. Ray Heath, "The Military Use of the Rail-Walking Test as
an Index of Locomotor Coordination," Psychological Bulletin, XL (April,

equilibrium in simple tasks, such as walking up stairs, after going without sleep for an extended period of time.\textsuperscript{29}

Travis studied 164 college men and 157 college women on dynamic balance in the standing position. Evidence indicates that students with previous athletic achievement in skating, dancing, riding, and gymnastics achieved scores that were a great deal above average. People who engaged in violent physical exercise, or who had drunk alcoholic beverages, or who were fatigued or had loss of sleep performed very poorly on the test.\textsuperscript{30}

Fischer, Birren, and Leggett studied 151 subjects and concluded that a substantial gain in learning was recorded as a result of practice for four days on a railwalking test.\textsuperscript{31}

**Summary**

After reviewing the foregoing studies it can be concluded that dynamic equilibrium is controlled by a number of diverse factors. Evidence indicates that performance on dynamic balance tests can be improved by training, but such things as fatigue, alcohol, and illness could handicap an otherwise reliable balance performance. Studies point out the need for consideration of sight and hearing before administering a test of equilibrium. There seems to be a steady


improvement in balance, with an adolescent lag, to about seventeen years of age, when performance levels off. The studies of racial differences indicate the need for further investigation.
CHAPTER III

METHODS OF RESEARCH

This study was designed as an attempt to determine whether any significant difference existed in dynamic balance among three selected ethnic groups.

When the experimental method is used, certain basic controls must be utilized. They are: "identification of the population, the selection of the subjects, establishment of the duration of the experiment and the elimination of extraneous influences." These limitations must be established before the experiment can begin.

Experimental Population The experimental population was comprised of thirty young men of Negro, Indian and white heritage from the states of North Dakota, Minnesota, and Florida. The mean age of the group was 17.23 years. The mean weight of the group was 153.9 pounds. The mean height of the group was 69.6 inches.

Four Indians came from the Red Lake Indian Reservation in Minnesota. One of the Indians came from the Turtle Mountain Indian Reservation in North Dakota. The remaining Indian was a resident of the Fort Totten Reservation in North Dakota.

The twelve American Negroes all came from Dillard High School.

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which was segregated, in Broward County, Florida.

Six white boys came from MacArthur High School in Broward County and the other six whites came from South Broward High School, also in Broward County. The last two schools are also segregated.

The age range of the total population of Negroes, whites, and Indians tested in this study was from seventeen to nineteen years.

The weight range of the group was from 120 pounds to 225 pounds, and the height of the group ranged from sixty four to seventy three inches.

The mean age of the Negroes was 17.16 years, the mean height was 68 inches, and the mean weight was 154.25 pounds (Figure 1).

The mean age of the whites was 17.08 years, the mean height was 70.83 inches, and the mean weight was 168 pounds (Figure 2).

The mean age of the Indians was 17.64 years, the mean height was 70.33 inches, and the mean weight was 150 pounds (Figure 3).

Requirements of the Population Fisher, Bachman, and Espenshade, Dable, and Schoendube, found that a plateau in balance learning takes place about the age of seventeen. For this reason the writer limited the experiment to boys seventeen years of age or older.

34Bachman, Research Quarterly, XXXII, No. 2, 193-197.
### FIGURE 1

**AMERICAN NEGROS, AGE, WEIGHT, HEIGHT, AND SPORTS LETTERED IN**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>Height</th>
<th>Weight</th>
<th>Sports Lettered In</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS</td>
<td>17</td>
<td>71</td>
<td>143</td>
<td>Football, basketball</td>
</tr>
<tr>
<td>FH</td>
<td>17</td>
<td>68</td>
<td>160</td>
<td>Football, basketball</td>
</tr>
<tr>
<td>RB</td>
<td>16</td>
<td>73</td>
<td>172</td>
<td>Baseball, basketball</td>
</tr>
<tr>
<td>JL</td>
<td>17</td>
<td>67</td>
<td>160</td>
<td>Basketball, football, track</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>baseball</td>
</tr>
<tr>
<td>WC</td>
<td>13</td>
<td>69</td>
<td>153</td>
<td>Football, track</td>
</tr>
<tr>
<td>GG</td>
<td>17</td>
<td>66</td>
<td>152</td>
<td>Football, basketball, baseball</td>
</tr>
<tr>
<td>HW</td>
<td>17</td>
<td>69</td>
<td>156</td>
<td>Swimming, football, diving</td>
</tr>
<tr>
<td>GS</td>
<td>17</td>
<td>68</td>
<td>149</td>
<td>Football, track</td>
</tr>
<tr>
<td>GF</td>
<td>17</td>
<td>64</td>
<td>160</td>
<td>Football, track, basketball</td>
</tr>
<tr>
<td>RR</td>
<td>17</td>
<td>65</td>
<td>144</td>
<td>Track, football, baseball, basketball</td>
</tr>
<tr>
<td>LW</td>
<td>17</td>
<td>65</td>
<td>130</td>
<td>Swimming, diving, basketball</td>
</tr>
<tr>
<td>GD</td>
<td>17</td>
<td>71</td>
<td>172</td>
<td>Football, track</td>
</tr>
</tbody>
</table>

Mean Age 17.16
Mean Height 68 inches
Mean Weight 154.25 pounds
### FIGURE 2

**AMERICAN INDIANS, AGE, HEIGHT, WEIGHT, AND SPORTS LETTERED IN**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>Height</th>
<th>Weight</th>
<th>Sports Lettered In</th>
</tr>
</thead>
<tbody>
<tr>
<td>DO</td>
<td>18</td>
<td>70</td>
<td>136</td>
<td>Football, basketball, baseball</td>
</tr>
<tr>
<td>DB</td>
<td>17</td>
<td>65</td>
<td>126</td>
<td>Basketball, baseball</td>
</tr>
<tr>
<td>GH</td>
<td>17</td>
<td>73</td>
<td>153</td>
<td>Football, basketball, track</td>
</tr>
<tr>
<td>DC</td>
<td>18</td>
<td>70</td>
<td>150</td>
<td>Football, basketball</td>
</tr>
<tr>
<td>LBHB</td>
<td>17</td>
<td>72</td>
<td>160</td>
<td>Football, basketball</td>
</tr>
<tr>
<td>BG</td>
<td>19</td>
<td>73</td>
<td>170</td>
<td>Basketball, baseball</td>
</tr>
</tbody>
</table>

**Mean Age** 17.64 years  
**Mean Height** 70.33 inches  
**Mean Weight** 150 pounds
### FIGURE 3

**AMERICAN WHITES, AGE, HEIGHT, WEIGHT, AND SPORTS LETTERED IN**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>Height</th>
<th>Weight</th>
<th>Sports Lettered In</th>
</tr>
</thead>
<tbody>
<tr>
<td>HM</td>
<td>17</td>
<td>68</td>
<td>140</td>
<td>Football, baseball</td>
</tr>
<tr>
<td>EL</td>
<td>17</td>
<td>68</td>
<td>120</td>
<td>Swimming, diving</td>
</tr>
<tr>
<td>BW</td>
<td>17</td>
<td>71</td>
<td>156</td>
<td>Swimming, cross country</td>
</tr>
<tr>
<td>AL</td>
<td>17</td>
<td>71</td>
<td>165</td>
<td>Football, track</td>
</tr>
<tr>
<td>JC</td>
<td>18</td>
<td>71</td>
<td>170</td>
<td>Football, track</td>
</tr>
<tr>
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<tr>
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<tr>
<td>AD</td>
<td>17</td>
<td>74</td>
<td>160</td>
<td>Basketball, baseball</td>
</tr>
</tbody>
</table>

Mean Age 17.08 years
Mean Height 70.83 inches
Mean Weight 168 pounds
Slatér-Hammel, 36 Munby, 37 Cross and Thompson38 have all concluded that the greater the athletic achievement, in most cases, the better the dynamic equilibrium. As a result of the above findings and because no studies were found on a comparison of balance among athletes competing in the various sports, the requirement that each subject should be a letter winner in two or more major sports was installed in order to more nearly equate the tested population.

Daniels39 and Massengill40 concluded that deafness affects equilibrium adversely. On the basis of the above conclusion, proof of adequate hearing was required of the participants. Bass41 and Travis42 found much evidence to support the contention that the eyes are one of the basic factors in determining equilibrium. In view of the evidence presented, normal sight was made a requirement of this examination.

TESTS USED

Bass Test. The directions for the administration of the Bass Test of Dynamic Balance are as follows: Circles, eleven in number and 9 1/2 inches in diameter, are drawn on the floor (Figures 4 and 5). The performer stands with his right foot on the starting circle, leaps (not steps) into the first circle with the left foot, leaps into the second circle with the right foot, and so on, from circle to circle, alternating the feet. The performer must leave the floor entirely in leaping from one circle before alighting in another, must alight upon the ball of the foot, and must not touch the heel to the floor. He should remain stationary in each circle for five seconds. The score for the trip is 50, plus the number of seconds taken to negotiate the test, minus three times the "errors."

37Munby, Research Quarterly, XXIV, No. 3, 327-32.
38Cross and Thompson, Research Quarterly, XXVIII, No. 4, 346.
39Daniels, 472-73.
40Massengill, The Volta Review, LXII, No. 1, 71.
42Travis, American Journal of Psychology, LVI, No. 3, 468.
Figure 4

DIAGRAM OF THE BASS TEST OF DYNAMIC BALANCE

Circles 9¹⁄₂" in diameter
X = starting circle
18" from X to circle 1
33" between other circles
FIGURE 5

DIAGRAM OF THE BASS TEST OF DYNAMIC BALANCE
PAINTED ON CONCRETE
The "errors" are as follows: (1) touching the heel to the floor, (2) moving the foot while standing in the circle, (3) hopping upon the supporting foot, (4) touching the floor outside the circle, (5) touching the foot with the other foot, (6) touching the floor with any other part of the body. Each error counts one penalty point; then if the performer, in endeavoring to maintain the balance in any one circle, hops four times, this is counted as four separate errors.

The test should be explained and demonstrated by the teacher or by a leader, and one or two practice trials be conducted without the use of the circles, the students checking spots on the floor and leaping to them. In giving the test, the timer counts the seconds, beginning the count as the performer alights in each circle. For example, after the performer jumps into the first circle, the timer, who has already started the watch, counts 1, 2, 3, 4, 5, beginning the count again on each subsequent circle. If the performer leaps to the next circle before the count of five, the count begins anew. If he remains in the circle more than five seconds, the extra time is deducted from the total time. The instructor accompanies the performer, and counts the errors silently and cumulatively. Three trials should be given, and the average of the three taken as the score. A minus score should be recorded as 0.

An r of reliability of .95 was obtained for this test when three trials were used. An r of .74 has been obtained between this test and ratings of general-motor ability in a group of college women, and an r of .69 with ratings of ability in rhythms and in dancing.

Watch Ticking Test

The hearing distance for the normal ear is 36 inches. The hearing score is recorded as the denominator. The distance that the subject hears the watch is the numerator. Eyes closed normal hearing is 36/36.

The subjects are tested with the eyes closed. The watch is brought toward one ear from a distance of about five feet. The performer is to indicate the exact time at which he hears the watch. The other ear is then tested.

---

H3 McCloy and Young, 106-7.

Before the experimental testing, the young men were told the nature and purpose of the experiment. All participants were asked to remain quiet during the actual testing so as not to distract the subject being tested.

The participants were then asked to examine the score sheet and to fill in the necessary information (Figure 6). If sight and hearing data were unavailable, the tests were given at this time. Next the subjects were given uniform instructions, along with a demonstration of the proper execution of the test by the experimenter. Following the explanation and demonstration each boy was allowed two practice trials.

Testing began at one o'clock on August 9, 1961 at the Red Lake Indian Reservation. The author was assisted by an instructor from the local high school. The site of the experiment was a new fire hall.

Four young Indian men were given the Watch Ticking Test. The hearing test was administered in a small room adjacent to the fire hall. Only the experimenter and one subject were in the room at one time.

The Snellen Scale Letter Chart was administered to determine whether or not the boys had normal vision. The test was administered in the fire hall. Again, each boy was the only one present with the experimenter during the examination.

The design of the Bass Test was laid out on the concrete floor in white chalk, with the aid of an angle board, circle, and straight edge designed by the author (Figures 7,8,9).
FIGURE 6
Data and Performance Sheet

<table>
<thead>
<tr>
<th>NAME</th>
<th>ETHNIC GROUP</th>
<th>AGE</th>
<th>HEIGHT</th>
<th>HEIGHT</th>
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<th>-3X errors</th>
<th>TOTAL</th>
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<table>
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<th>-3X errors</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 7

ANGLE BOARD
Designed by
J. W. Doyle
BASS TEST CIRCLE
Designed by
J. W. Doyle
Instructions were given, the score sheets were filled out, and the subjects were given two trials. Then three tests were given for score. Scores were tabulated and an average was derived.

The testing of the fifth American Indian took place in a gymnasium on the Turtle Mountain Indian Reservation in North Dakota. The time was twelve noon on August 14, 1961. The subject's sight and hearing tested normal. An instructor from the local high school assisted the experimenter.

The final representative of the Indians was tested in an Indian Agency office at Fort Totten, North Dakota at five o'clock on August 14, 1961. A teacher from the high school at Devils Lake did the assisting. The hearing and sight tests were used.

All Negroes used in this study were tested September 26, 1961 at 10:30 A.M. at Dillard High School, Broward County, Florida. The author was assisted by a guidance instructor from Parkway Junior High School.

Sight and hearing examinations were not deemed necessary as records were available to all school personnel.

The design of the Bass Test was laid out as in all previous examinations conducted in this study. A large quiet area adjacent to the gym, with a concrete floor, was the site of the experiment.

The first group of six young white male subjects was tested on a handball court at one o'clock March 16, 1962, at MacArthur High School in Broward County, Florida. Sight and hearing information was again available to the examiner, making it unnecessary to repeat the tests. Parkway's guidance instructor assisted the author in the experiment.
The final six white performers were examined in a gymnasium at South Broward High School (Figure 10) in Broward County, Florida. The tests were held at 3:00 P.M., April 3, 1962. The writer was assisted by the Parkway Junior High School guidance instructor. A check of the hearing and sight of the subjects was made.

TREATMENT OF THE DATA

In order to determine the difference, if any, among the three ethnic groups in this study, the significance between means was investigated.

Null Hypothesis

The test of null hypothesis was considered the most objective method of evaluating this data. The above hypothesis was tested by the significance of t which is the appropriate critical ratio to be used with small samples of uncorrelated means. "A null hypothesis is ordinarily more useful than other hypotheses because it is exact."^5

This hypothesis asserts that there is no true difference between two population means, and that the difference found between samples is, therefore, accidental and unimportant. If our null hypothesis is untenable we must reject it."^6

Rejection of the null hypothesis means that the difference is really too large to be attributed to chance.

Mean

The mean is the sum of the scores divided by their number, thus, each separate score affects this measure of central tendency in direct proportion to its magnitude and position in the distribution. The mean expresses the central massing of scores according to the distance the scores fall from the mean. It is, therefore, a deviation measure of central tendency, as each score in the distribution is weighted by its distance from central


^6Garrett, 213.
FIGURE 10
EXECUTION OF BASS TEST OF DYNAMIC BALANCE
SOUTH BROWARD HIGH SCHOOL
HOLLYWOOD, FLORIDA
tendency, as each score in the distribution is weighted by its
distance from central tendency. With ungrouped data, the mean is
calculated by adding the scores and dividing by the number.

It is calculated by the equation: \( \bar{X} = \frac{\sum X}{N} \).

When \( N \) = the mean

\[ \text{= the sum of} \]

\( X \) = each of the individual measurements of scores

\( N \) = the number of measurements in the series

**Sum of the Squared Deviations**

The sum of the squared deviations is calculated by first placing the indivi-
dual scores in a column. Derive the mean by the formula \( \bar{X} = \frac{\sum X}{N} \).

Calculate the deviation from the mean by subtracting the mean from each value and entering this score in a column to the right of each value. Each of these deviations are then squared and entered in a column to the right of the preceding column. By totaling the squared numbers, the sum of the squared deviations is calculated.

\[ \sum x^2 = \text{sum of} \]

\( x \) = deviation of a value from the mean

\( x^2 \) = deviation of a value from the mean squared

\[ \sum x^2 = \text{sum of the deviations squared} \]

**The Standard Deviation**

When the \( N \)'s of two independent groups are small (less than 30 say) the SE of the dif-
fferences between means should depend upon SD's calculated by the formula

\[ SE = \frac{\sqrt{\sum x^2}}{N} \]

---

SD = $\sqrt{\frac{\sum x^2}{N - 1}}$ and the degrees of freedom in the two groups must be considered. The standard deviation indicates the scatter or spread of the middle 60.26 percent of the scores taken from the mean.

The standard deviation is calculated by dividing the sum of the deviations squared by the number of scores $=1$. The square root of this sum is the standard deviation. $SD = \sqrt{\frac{\sum x^2}{N - 1}}$.

SD or $\sigma$ = standard deviation
$\sqrt{}$ = square root
$N$ = number of cases

Standard Error of the Mean

It is known that there is a tendency for the standard deviation of a sample to underestimate the population, and this could be severe in cases of small samples. In order to correct any underestimation of the population, the formula used to find the standard error of the mean was:

$$\sigma_m = \frac{\sigma}{\sqrt{N}}$$

$\sigma_m$ = standard error of the mean

Standard Error of the Difference Between Means

The standard error of the difference between means is calculated by taking the square root of the sum of the squares of the two standard errors of the means of the problem under consideration. The following formula was used to determine the standard error of the difference between means:

$\text{48 Garrett, 222.}$

$\text{49 Ibid., 189.}$
\[ \sigma_D = \sqrt{\sigma^2_{m_1} + \sigma^2_{m_2}} \]

\[ \sigma_D = \text{standard error of difference of the means} \]

**t-Score**  
The t score is devised by dividing the difference of two means by the standard error of the difference of the means.

\[ t = \frac{D}{\sigma_D} \]

\[ D = \text{actual difference of the mean} \]

**Degree of Freedom**  
It is necessary to compute the degree of freedom in order to utilize the table of t in order to ascertain the significance of the statistics. It is computed in the following manner:

\[ df = N - 1 \]

\[ df = \text{degree of freedom} \]

In a comparison of means the method used would be \((N_1 - 1 + N_2 - 1)\) and \((N_2 - 1 + N_3 - 1)\).

**Levels of Significance**  
The level of significance used in this study was .01. However, the .02 and .05 levels were listed. The t scores were computed on the table to test their significance as to whether or not the null hypothesis would be retained or rejected.
CHAPTER IV

ANALYSIS OF DATA

The purpose of this study was an attempt to determine whether or not any significant difference existed in dynamic equilibrium among American Indians, American Negroses, and American Caucasians. The method of calculating the data has been discussed in Chapter III.

The statistical calculations of the data which include the tabulation of the raw scores to a consideration of the mean, the sum of the deviation squared, the square root, the standard error of the mean, the standard error of the difference between two means, the t score, and the levels of significance are found in detail with the statistical methods involved in the Appendix.

FIGURE 11


<table>
<thead>
<tr>
<th>Ethnic Group</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Standard Error of the Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>American White</td>
<td>84.75</td>
<td>6.61</td>
<td>1.91</td>
</tr>
<tr>
<td>American Indian</td>
<td>79.17</td>
<td>6.25</td>
<td>2.55</td>
</tr>
<tr>
<td>American Negro</td>
<td>92.11</td>
<td>7.21</td>
<td>2.06</td>
</tr>
</tbody>
</table>

Inspection of Figure 11 illustrates that the Negro group had the highest mean at 92.11 and the Indians the lowest at 79.17.
The white group's mean was 34.75. The standard deviations of the three groups ranged from 6.25 to 7.22. The standard deviation for the whites was 6.61, for the Indians 6.25, and for the Negroes 7.21. The standard errors of the mean for the three groups were as follows: Negro 2.08, white 1.91, and Indian 2.55.

**FIGURE 12**

THE STANDARD ERROR OF THE DIFFERENCE BETWEEN UNCORRELATED MEANS, T SCORE, AND LEVELS OF SIGNIFICANCE OF AMERICAN INDIANS AND AMERICAN WHITES

<table>
<thead>
<tr>
<th>$\sigma_D$</th>
<th>t score</th>
<th>Levels of Significance</th>
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</thead>
<tbody>
<tr>
<td>3.19</td>
<td>1.75</td>
<td>0.05 0.02 0.01</td>
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In the comparison of statistics of whites and Indians, it was observed from Figure 12 that the standard error of difference between means was 3.19, and the t score was 1.75. The t value at 1.75 with 16 degrees of freedom, indicated no significant difference at the .01 level of significance which was established as the criterion in this study. The null hypothesis was retained.

**FIGURE 13**

THE STANDARD ERROR OF THE DIFFERENCE BETWEEN UNCORRELATED MEANS, T SCORE, AND LEVELS OF SIGNIFICANCE OF AMERICAN WHITES AND AMERICAN NEGROES

<table>
<thead>
<tr>
<th>$\sigma_D$</th>
<th>t score</th>
<th>Levels of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.82</td>
<td>2.61</td>
<td>0.05 0.02 0.01</td>
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</tbody>
</table>
A comparison of data between whites and Negroes from Figure 13 revealed that the standard error of difference between means was 2.82. The t value of 2.61 was not significant at the .01 level of confidence; however, it was significant at the .02 level. The null hypothesis was retained.

FIGURE 14

THE STANDARD ERROR OF THE DIFFERENCE BETWEEN UNCORRELATED MEANS, t SCORE, AND LEVELS OF SIGNIFICANCE OF AMERICAN INDIANS AND AMERICAN NEGROES

<table>
<thead>
<tr>
<th>$\sigma_D$</th>
<th>t score</th>
<th>.05</th>
<th>.02</th>
<th>.01</th>
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</thead>
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<tr>
<td>3.29</td>
<td>3.93</td>
<td>2.12</td>
<td>2.53</td>
<td>2.92</td>
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</table>

In comparing the statistical evaluation of the Indian and Negro populations in Figure 14 of this study, it was found that the standard error of the difference between means was 3.29. The t value of 3.93 was significant at the .01 level of confidence. The null hypothesis was rejected. The Negro subjects in this experiment scored significantly higher than Indians on the Bass Test of Dynamic Balance.
Thirty young men were tested in an attempt to find out if there were any significant differences in dynamic balance among selected American Negroes, American whites, and American Indians. Six American Indians were tested during the summer of 1961 in Minnesota and North Dakota. The Negroes were tested in the fall of 1961 in Florida, and the white group was tested in Florida in the spring of 1962.

Although there were few studies of dynamic balance, it was evident that this trait is a very important component of ability to learn and perform sports skills. A great many factors determine equilibrium. Based on findings in the related literature available, it was decided to limit the study to males seventeen or older with good eyesight, hearing, and with varied athletic backgrounds.

A sight and hearing test was administered when necessary. The Bass Test of Dynamic Balance was chosen as the most suitable instrument available for this study.

A statistical comparison was made among the three ethnic groups investigated in this paper. The null hypothesis, which states that the true difference is zero, was tested. As this study is concerned with uncorrelated small samples, the t test was used to determine the retention or rejection of the null hypothesis. The .01 level of significance was established as the acceptable point of confidence on the Table of t, for rejection of the null hypothesis.
Conclusions

The results of this investigation indicate the following:

1. The comparison of whites with Indians revealed no significant difference in their dynamic equilibrium.

2. The Negro subjects who participated in this study were not significantly superior at the .01 level to the white subjects studied. The mean difference of 7.26 in favor of the Negroes did produce a t of 3.61 which would have been significant at the .02 level, had this criterion been adopted.

3. The mean difference of 12.94 in favor of the Negroes over the Indians in this study produced a t of 3.93, which was significant at the .01 level of confidence. Negroes in this experiment were significantly superior to the Indians in dynamic equilibrium as measured by the instruments in this study.

Recommendations

1. A study should be made to attempt to determine in which sports dynamic balance is of most importance.

2. A similar study should be made with other ethnic groups.

3. A study should be made to test the effects of balance training in a specified sport.

4. A similar study should be made with larger samples of the three ethnic groups in this study.

5. A similar study should be made with average performers.

6. A study should be made on the equilibrium of more select performers.

7. This study should be repeated using a railwalking test.
BIBLIOGRAPHY

Books


Periodicals


St. Mary, Maurice. "Teaching About the American Indian," Social Studies, XLV (April, 1954), 149.


### Scores of Three Trials and Average Score of American Indians

<table>
<thead>
<tr>
<th>Subject</th>
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<th>Trial 2</th>
<th>Trial 3</th>
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DEVIATION, AND THE STANDARD ERROR OF THE MEAN
OF UNCORRELATED SCORES OF AMERICAN WHITES

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<td>9.25</td>
<td>85.56</td>
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<td>2. ML</td>
<td>89</td>
<td>4.25</td>
<td>18.06</td>
</tr>
<tr>
<td>3. BW</td>
<td>82</td>
<td>2.75</td>
<td>7.56</td>
</tr>
<tr>
<td>4. AL</td>
<td>92</td>
<td>6.25</td>
<td>39.06</td>
</tr>
<tr>
<td>5. GC</td>
<td>72</td>
<td>9.75</td>
<td>99.06</td>
</tr>
<tr>
<td>6. PS</td>
<td>86</td>
<td>1.25</td>
<td>1.56</td>
</tr>
<tr>
<td>7. JF</td>
<td>86</td>
<td>1.25</td>
<td>1.56</td>
</tr>
<tr>
<td>8. JB</td>
<td>85</td>
<td>0.25</td>
<td>0.63</td>
</tr>
<tr>
<td>9. DB</td>
<td>88</td>
<td>3.25</td>
<td>10.56</td>
</tr>
<tr>
<td>10. TS</td>
<td>79</td>
<td>4.75</td>
<td>22.56</td>
</tr>
<tr>
<td>11. RM</td>
<td>76</td>
<td>8.75</td>
<td>76.56</td>
</tr>
<tr>
<td>12. AD</td>
<td>90</td>
<td>5.25</td>
<td>27.56</td>
</tr>
</tbody>
</table>

\[ N = 12 \]
\[ \sum x^2 = 480.29 \]

\[ N = \frac{x}{N} \]
\[ N = 34.75 \]

\[ \sigma = \sqrt{\frac{\sum x^2}{N-1}} \]
\[ \sigma_m = \frac{\sigma}{\sqrt{N}} \]

\[ \sigma = \sqrt{\frac{49.56}{11}} \]
\[ \sigma_m = \frac{5.61}{\sqrt{12}} \approx 1.91 \]

\[ \sigma = \sqrt{49.56} \]
\[ \sigma_m = \frac{6.61}{\sqrt{12}} \approx 1.91 \]

\[ \sigma = 6.61 \]
DEVIATION, AND THE STANDARD ERROR OF THE MEAN
OF UNCORRELATED SCORES OF AMERICAN INDIANS

<table>
<thead>
<tr>
<th>Subject</th>
<th>Score</th>
<th>( z )</th>
<th>( z^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. LMB</td>
<td>83</td>
<td>3.83</td>
<td>14.67</td>
</tr>
<tr>
<td>2. DB</td>
<td>86</td>
<td>6.83</td>
<td>46.65</td>
</tr>
<tr>
<td>3. DC</td>
<td>75.33</td>
<td>3.95</td>
<td>15.75</td>
</tr>
<tr>
<td>4. GM</td>
<td>69.67</td>
<td>10.50</td>
<td>110.25</td>
</tr>
<tr>
<td>5. DG</td>
<td>82</td>
<td>2.83</td>
<td>8.03</td>
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<tr>
<td>6. RG</td>
<td>80</td>
<td>1.83</td>
<td>3.69</td>
</tr>
<tr>
<td></td>
<td>( N = 6 )</td>
<td>( \sum z^2 = 195.02 )</td>
<td></td>
</tr>
</tbody>
</table>

\[ N = \frac{X}{M} \quad M = 79.17 \]

\[ \sigma = \sqrt{\frac{\sum z^2}{N-1}} \]

\[ \sigma_m = \frac{\sigma}{\sqrt{N}} \]

\[ \sigma = \sqrt{\frac{195.02}{5}} \]

\[ \sigma_m = \frac{6.25}{\sqrt{6}} = \frac{6.25}{2.45} = 2.55 \]

\[ \sigma = 6.25 \]
### Table: The Mean, the Sum of the Deviation Squared, the Standard Deviation, and the Standard Error of the Mean of Uncorrelated Scores of American Negroes

<table>
<thead>
<tr>
<th>Subject</th>
<th>Score</th>
<th>$x$</th>
<th>$x^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. RS</td>
<td>97</td>
<td>4.89</td>
<td>23.91</td>
</tr>
<tr>
<td>2. RM</td>
<td>83</td>
<td>4.11</td>
<td>16.89</td>
</tr>
<tr>
<td>3. RB</td>
<td>72.33</td>
<td>19.78</td>
<td>391.25</td>
</tr>
<tr>
<td>4. JL</td>
<td>95</td>
<td>2.89</td>
<td>8.35</td>
</tr>
<tr>
<td>5. JC</td>
<td>96.33</td>
<td>4.22</td>
<td>17.81</td>
</tr>
<tr>
<td>6. GG</td>
<td>92.33</td>
<td>2.22</td>
<td>4.88</td>
</tr>
<tr>
<td>7. JW</td>
<td>99</td>
<td>6.89</td>
<td>47.47</td>
</tr>
<tr>
<td>8. JS</td>
<td>92.33</td>
<td>2.22</td>
<td>4.88</td>
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<tr>
<td>9. CJ</td>
<td>99</td>
<td>6.89</td>
<td>47.47</td>
</tr>
<tr>
<td>10. IR</td>
<td>96</td>
<td>3.89</td>
<td>15.13</td>
</tr>
<tr>
<td>11. LI</td>
<td>98</td>
<td>5.89</td>
<td>34.69</td>
</tr>
<tr>
<td>12. GO</td>
<td>90</td>
<td>2.11</td>
<td>4.45</td>
</tr>
</tbody>
</table>

$N = 12$  
$\sum x^2 = 570.53$

$\bar{X} = \frac{\sum x}{N}$  
$\bar{X} = 92.11$

\[ \sigma = \sqrt{\frac{\sum x^2}{N-1}} \]  
\[ \sigma_m = \frac{\sigma}{\sqrt{N}} \]  
\[ \sigma = \sqrt{570.53} \]  
\[ \sigma_m = \frac{7.21}{\sqrt{12}} = 7.21 \cdot \frac{1}{3.46} = 2.08 \]  
\[ \sigma = \sqrt{51.87} \]  
\[ 7.21 \]
STANDARD ERROR OF THE DIFFERENCE BETWEEN UNCORRELATED MEANS, 
T VALUES, DEGREES OF FREEDOM, AND LEVELS OF SIGNIFICANCE 
BETWEEN AMERICAN WHITES AND AMERICAN INDIANS

\[ \sigma_D = \sqrt{\sigma^2_{11} + \sigma^2_{22}} \]

\[ \sigma_D = \sqrt{(1.92)^2 + (2.55)^2} \]

\[ \sigma_D = \sqrt{3.65 + 6.5} \]

\[ \sigma_D = \sqrt{10.13} \]

\[ \sigma_D = 3.19 \]

\[ t \text{ value} = \frac{D}{\sigma_D} \text{ or } \frac{N_2 - N_1}{\sigma_D} \]

\[ t = \frac{84.75 - 72.17}{3.19} = \frac{5.58}{3.19} = 1.75 \]

\[ df = \text{degrees of freedom} \]

\[ df = (N_1 - 1) + (N_2 - 1) \]

\[ df = 16 \]

Levels of Significance

\[ t \text{ at the .05 level} = 2.12 \]

\[ t \text{ at the .02 level} = 2.53 \]

\[ t \text{ at the .01 level} = 2.92 \]
STANDARD ERROR OF THE DIFFERENCE BETWEEN UNCORRELATED MEANS, t VALUES, DEGREES OF FREEDOM, AND LEVELS OF SIGNIFICANCE
BETWEEN AMERICAN WHITES AND AMERICAN NEGROES.

\[ \sigma_d = \sqrt{\sigma_1^2 n_1 + \sigma_2^2 n_2} \]

\[ \sigma_d = \sqrt{(1.91)^2 + (2.08)^2} \]

\[ \sigma_d = \sqrt{3.65 + 4.33} \]

\[ \sigma_d = \sqrt{7.98} \]

\[ \sigma_d = 2.82 \]

\[ t = \frac{D}{\sigma_d} \text{ or } \frac{\mu_1 - \mu_2}{\sigma_d} \]

\[ t = \frac{92.13}{2.82} = 33.75 \]

\[ df = \text{degrees of freedom} \]

\[ df = (n_1 - 1) + (n_2 - 1) \]

\[ df = 22 \]

Levels of significance

\[ t \text{ at the .05 level} = 2.07 \]

\[ t \text{ at the .02 level} = 2.51 \]

\[ t \text{ at the .01 level} = 2.82 \]
STANDARD ERROR OF THE DIFFERENCE BETWEEN UNCORRELATED MEANS, 
\( t \) VALUES, DEGREES OF FREEDOM, AND LEVELS OF SIGNIFICANCE 
BETWEEN AMERICAN INDIANS AND AMERICAN NEGROES

\[
\sigma_D = \sqrt{\sigma^2_{M_2} + \sigma^2_{M_3}}
\]

\[
\sigma_D = \sqrt{(2.55)^2 + (2.08)^2}
\]

\[
\sigma_D = \sqrt{6.5 + 4.33}
\]

\[
\sigma_D = \sqrt{10.83}
\]

\[
\sigma_D = 3.30
\]

t value = \[
\frac{D}{\sigma_D} \quad \text{or} \quad \frac{M_2 - M_3}{\sigma_D}
\]

\[
t = \frac{92.11 - 79.17}{3.29} = \frac{12.94}{3.29} = 3.93
\]

\( \text{df} \) = degrees of freedom

\[
\text{df} = (n_2 - 1) + (n_3 - 1)
\]

\[
\text{df} = 16
\]

Levels of Significance

\( t \) at the .05 level = 2.12
\( t \) at the .02 level = 2.53
\( t \) at the .01 level = 2.92