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The Effect of Wearing or Not Wearing Glasses Upon the Balance of Bespectacled Athletes

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THE EFFECT OF WEARING OR NOT WEARING GLASSES UPON THE BALANCE OF BESPECTACLED ATHLETES

BY

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This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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CHAPTER I

INTRODUCTION

Balance, an interesting characteristic of all humans, is defined as the ability of the individual to control organic equipment neuromuscularly.[1] Balance is found in many degrees, from the man walking the tight rope in the circus and the halfback with his tricky broken field running in football to the young child who hasn't quite learned how to sit up. Each of these acts require balance. Physical education instructors and athletic coaches consider balance an important factor in the athletic success of a competitor. The wearing or the not wearing of glasses has also presented many problems to the physical education and athletic professions. It was the author's hypothesis that the wearing or the not wearing of glasses would affect balance and therefore have an influence on the performance of the individual engaging in physical education or athletic activities.

Statement of the Problem

The purpose of this study was to find the relationship of balance among bespectacled male athletes, performing while wearing and while not wearing their glasses.

Delimitations

1. The study was limited to 27 male bespectacled athletes.

2. The group tested was made up of a volunteer group of college athletes engaging in one or more intercollegiate sports.

3. The tests were administered during one testing period for each individual.

4. Only static and dynamic balance were tested.

5. The author lacked control of the motivation of the subjects.

6. The degree of eye difficulty was not considered.

Significance of the Problem

Several studies have been made in the area of balance, but very little has been done regarding relation of balance of bespectacled individuals who perform while wearing or not wearing their glasses. It was hoped that the results of this study would prove very important to physical educators and athletic coaches because balance is an important special ability needed for athletic success.

Definition of Terms

1. Balance--"Balance is the ability of the individual to control organic equipment neuromuscularly."[2]

2. Static balance--"Static balance is the maintenance of a specified posture with a minimum of body sway."[3]

3. Dynamic balance--"Dynamic balance is the maintenance of posture under conditions of continuous change of body position so as to require further muscular activity to re-establish body posture."[4]

CHAPTER II

REVIEW OF LITERATURE

Several researchers who conducted studies regarding balance have made various contributions in certain specific aspects or phases of the problem of balance. Whelan, for example, identified eight factors or components involved in balance. Of these eight, two were tentatively identified as eye factors. He called these Type I and Type II static-balance eye factors.[5] He also identified definitely two balance factors related to the eyes, the dynamic balance eye factor which functioned most in the beam tests (tests in which the subjects walk on beams of decreasing width, all of equal height from the floor) and the convergence-of-eyes factor which functioned most in the landmark tests (tests in which a subject must concentrate on a spot while balancing). This latter factor involved judgment of distance forward and backward performed during the Crosswise Stick Test.[6]

Bass stated the following as a result of her findings:

> ...the general function of balance is composed of a number of different factors or components. One of these is obviously concerned only with the functioning of the eyes in balance. Others function only when the eyes are open, hence there are probably several functions of the eyes in balance.[7]

Culhane made this statement about the ability to balance:

> The ability to balance is the result of the interrelationship between kinesthetic impulses received by the proprioceptors in the muscles, joints and ligaments, and the function of the semi-circular canals, along with visual perception aiding the feeling of position.[8]

Magnus found the role of vision highly dominant in head balance. As animals become more complex, they require labyrinthine reflexes less and the eye reflexes more. He found attitudinal reflexes in lower animals more apparent than in man and monkeys. Human posture was influenced by many afferent impulses which affect the postural reflexes. These in turn acted as a group to integrate the whole body musculature.[9] Brodie described a chain of muscles which controlled head posture and formed a unit capable of balance, the post-cervical muscles being the larger to oppose the force of gravity as well as the anterior chain of muscles.[10] Halbret made an electromyographic study of head posture. His study showed the movement of the head was always synergistic with the muscles operating to contribute to the smooth coordination of action.[11]

Maroney reported that all big muscle skills depend upon aid from the eyes, the semi-circular canals, and a healthy neuromuscular mechanism in adjusting muscle positions in equilibrium. At least two of these judgments are necessary for a person to do any complicated equilibrium movements. Blind people are handicapped in walking. If two of these functions are impaired, skilled acts in big muscle balance are difficult or impossible, depending upon the degree of the injury. Inner-ear deaf people will not attempt to walk across a plank in the night that they would readily try in the daylight. Deafness and temporary blindness reduce balance judgments to muscle sense. Either the eyes or the ears must aid muscle sense to make equilibrium possible. Standing on one foot with the eyes closed is more difficult than with the eyes open because the eye judgment is taken away. This causes balance to become chiefly a matter of muscle sense and semi-circular canals.[12]

Bass, one of the first persons to investigate balance, attempted to devise a series of tests to reliably measure static and dynamic balance. She devised two tests for balance, the Stick Test for measuring static balance and the Stepping Stone Test for measuring dynamic balance. The Stick Test was validated against rhythm ratings and general-motor ratings. The r's of reliability ranged from .721 to .901. The r's obtained between the tests and the rhythm ratings ranged from .2840 to .4647. The r's that were obtained between the tests and the general-motor ratings ranged from .2770 to .4745. Although the static balance test did not correlate highly with the criteria, Bass concluded the Stick Test was reliable and valid for mass testing situations. The Stepping Stone Test was validated against rhythm ratings and general-motor ratings. The Stepping Stone Test was found to have a reliability of .952, an r of .739 with rhythm ratings, and an r of .667 with general-motor ratings.[13]

Wiebe found that the tests using the Lengthwise Stick Test resulted in a reliability of .94 for college men.[14] Fisher, using the same test, obtained a reliability of .82 for the right foot and .84 for the left foot for high school girls.[15] McCloy stated that if the Lengthwise Stick Test and the Crosswise Stick Test are each given six times in all to each individual, the reliability of these tests will run from .80 to .90. They correlated about .5 with ratings of general-motor ability in women and similarly with rhythm ratings. McCloy in discussing these correlations stated, "These correlations, while rather low, are really surprisingly high when one considers the large number of other elements which go to make up general-motor ability."[16]

Seashore developed the Springfield Beam-Walking Test. This test was made of nine oak beams of varying widths, all of equal height from the floor. This test was found to have a reliability too low for practical usefulness.[17] Later Whitney developed a Walking Beam Test of four beams, each 10 feet long, with walking surfaces of 1½, 1, ½, and ¼ inches wide. The subjects walked in heel-to-toe fashion with the hands on the hips and with the eyes open. The average of five trials had a reliability coefficient of more than .80.[18]

The Rail-Walking Test was used with soldiers as subjects. Heath stated the following regarding his experiment:

> During training experience with problem soldiers in the special training unit, the author has observed that all persons with coordination problems do not necessarily have a low rail walking score....Finally the Rail-Walking Test must not be considered when fine differentiation is needed.[19]

Fisher, Birren, and Leggett also reported that the Rail-Walking Test was not satisfactory for work with small populations.[20]

In 1932, Alden, Horton and Caldwell used a balance beam and recorded the number of feet walked on the beam. Reliability for this test was very low.[21]

A Balance Leap Test (Sideward Leap Test) has also been developed to measure dynamic balance. This test is performed by having the subject stand on one foot, leap sideward to a designated spot, bend forward immediately and touch the floor, then lift the fingertips just above the floor and hold the position for five seconds. Roloff, in studying the relationship of kinesthesis to learning of selected motor skills, found a reliability for the Balance Leap Test of .65.[22] Scott and French found a reliability coefficiency of .88 for the Balance Leap Test when computed on alternate trials of a series of ten and stepped up by the Spearman-Brown formula. Subjects for their tests were 116 college students.[23]

Travis investigated several problems related to balance; among those studied were these: (1) What was the relative importance of the visual sense fields in postural balance? (2) What was the correlation between static equilibrium as measured by the ataxiameter and dynamic equilibrium as measured by the stabilometer? His conclusions indicated that (1) Both static and dynamic equilibrium were aided greatly when visual cues were present—the finer the visual points of reference the better the performance. (2) The dynamic component of equilibrium was unrelated to the static component. (3) There was evidence for assuming the presence of a steadiness factor in balancing skill and in eye-manual coordination as indicated by correlations in the order of .50.[24]

Whelan administered a battery of balance tests to a group of totally blind subjects and compared the results to the results of blindfolded sighted subjects on the same tests. He found little difference in balance between blind and blindfolded sighted individuals. This indicates that a sense of balance in the blind probably does not become highly developed to compensate for the loss of sight, as do other senses such as hearing and touch.[25]

Tyler (1) investigated the relationship between certain balance measures and skill in swimming, basketball, and gymnastics; (2) compared static balance ability with dynamic balance ability; and (3) studied the relationship of height and weight to the ability to balance. He used five tests of balance, the Beam-Walking Test, the Stepping Stone Test, the Stick Test (eyes open), the Stick Test (eyes closed), and a specially designed balance board. The tests were administered to 233 subjects enrolled at Pennsylvania State University. He chose subjects from required physical education classes, swimming classes, the varsity basketball team, and the varsity and freshman gymnastic teams. His conclusions indicated the following relationships: (1) A relationship between swimming ability and types of balance measured by the Stepping Stone Test, Beam-Walking Test and the Stick Tests. (2) Little or no relationship between basketball ability and ability to balance as measured by the tests used. (3) Some relationship between gymnastic ability and dynamic balance ability as measured by the Beam-Walking Test and the Stepping Stone Test. (4) Little relationship between static balance and dynamic balance as measured by the tests used. (5) Little relationship existing between height and weight and balance abilities which are specific to certain types of skill in sports and activities.[26]

Fawrup concluded from her study of the relationship of dynamic balance to success in social dancing that dynamic balance is not a predictor of success, although social dancing involves dynamic balance while moving backward. This is especially true for the woman dancer.[27]

Greenlee made a study of 122 college women in beginning bowling classes at the State University of Iowa. Bowling performance was determined by averaging six games rolled during the last three weeks of the instructional period. She drew the following conclusions: (1) There was a positive relationship, which was significant at the one per cent level, between dynamic balance and bowling performance. (2) There was no statistically significant relationship between bowling performance and strength, kinesthesis or static balance as measured by her study. (3) There was a positive significant relationship between rotary positioning of the forearm and dynamic balance.[28]

Riley studied balance as demonstrated by elementary boys and girls. She concluded that balance tests have low reliability at these grade levels, although balance ability improves at each grade level. Dynamic balance was the most difficult for grades one, two and three.[29]

In a study made by Garrison on the balance ability of college women, she found that a positive relationship existed between motor ability and balance ability, but that the relationship was very slight.[30] She also found that balance could be improved through the teaching of exercises of balance, but that a comparison of the balance gain and performance ability in selected activities did not show a relationship.[31]

Seashore found that height and weight had a bearing on balance.[32] Espenschade, Dable, and Schoendube concluded that neither height nor weight were important in dynamic balance.[33] Travis found weight to be a factor in dynamic balance of men in his equilibrium study.[34]

In discussing variations in balance, Scott and French stated,

> Variations appear because some have been trained to use kinesthetic awareness as a basis for balance and weight control; others have never had such awareness through their own efforts.
>
> Experience has shown that excessive fatigue, particularly long-term chronic fatigue, reduces balance control. Balance tests appear to be useful in somewhat of a diagnostic or interpretive way. For example, poor balance may explain erratic performance on certain skills, tension in trying to perform static activities, poor performance on activities such as skating, skiing, diving, dancing, trampolining, or others where dynamic balance is important. Also, a marked drop in ability to balance may be associated with fatigue.[35]

Culhane tested 65 subjects for static and dynamic balance before and after pedaling a bicycle ergometer. Contrary to Scott and French, she found that fatigue brought about by physical activity would not affect balance and that physical education instructors need not be concerned about this fact.[36]

CHAPTER III

PROCEDURE

The subjects in this study were athletes who wore glasses and have participated in one or more intercollegiate sports. The group consisted of 27 volunteer athletes. No attempt was made to classify the athletes as to age, weight, or height.

Testing Procedure

Three tests of balance were administered to the athletes. The tests used in this study were the Lengthwise Stick Test, the Crosswise Stick Test, and the Sideward Leap Test. Each test was administered three times during the one testing period.

The Lengthwise and Crosswise Stick Tests measured static balance. These tests involved balance on a stick 1 inch wide, 1 inch high and 12 inches long. The subjects balanced on the stick in a lengthwise position (Figure I) and also in a crosswise position (Figure II). Directions were similar for both tests; the only difference involved the change in position. For a complete description of the Stick Tests, see Appendix A.[37]

The Sideward Leap Test measured dynamic balance. It was administered on a pre-painted diagram on the floor (Figure III). The subjects were tested for dynamic balance on both the right and left foot. For a complete description of the Sideward Leap Test, see Appendix B.[38] Because of crowded schedules, the subjects were tested individually or in groups of two. Tests were administered by the author and fellow graduate assistants.

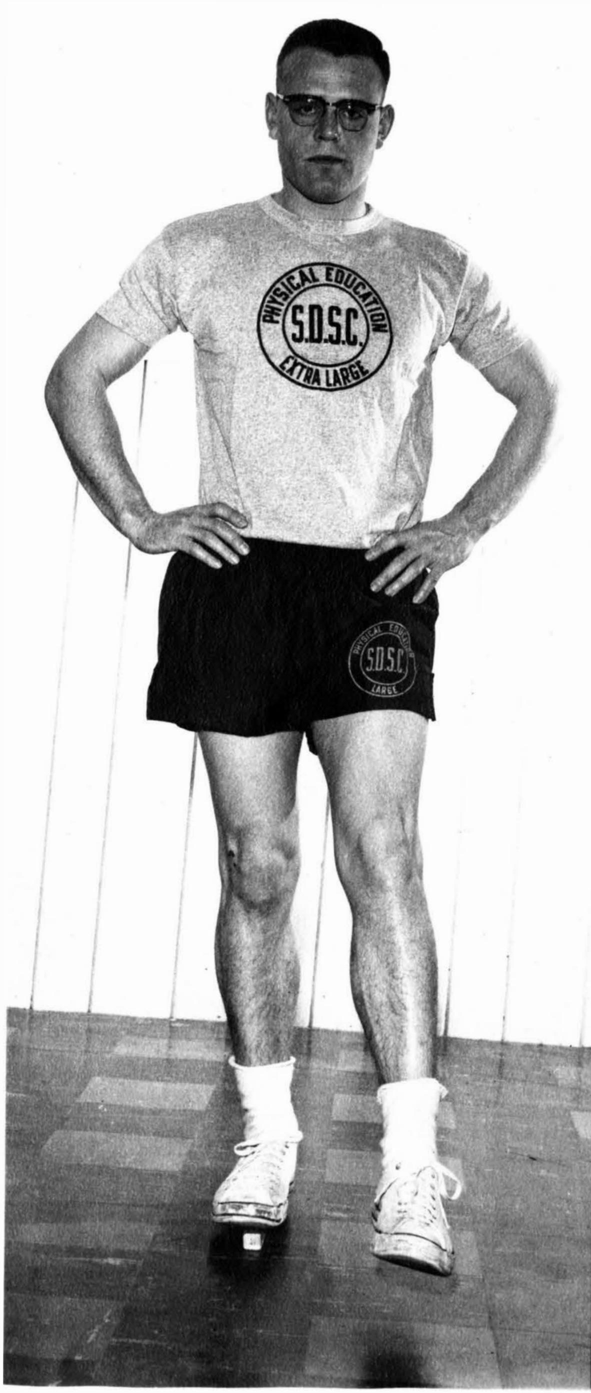

Figure I. Lengthwise
Stick Test

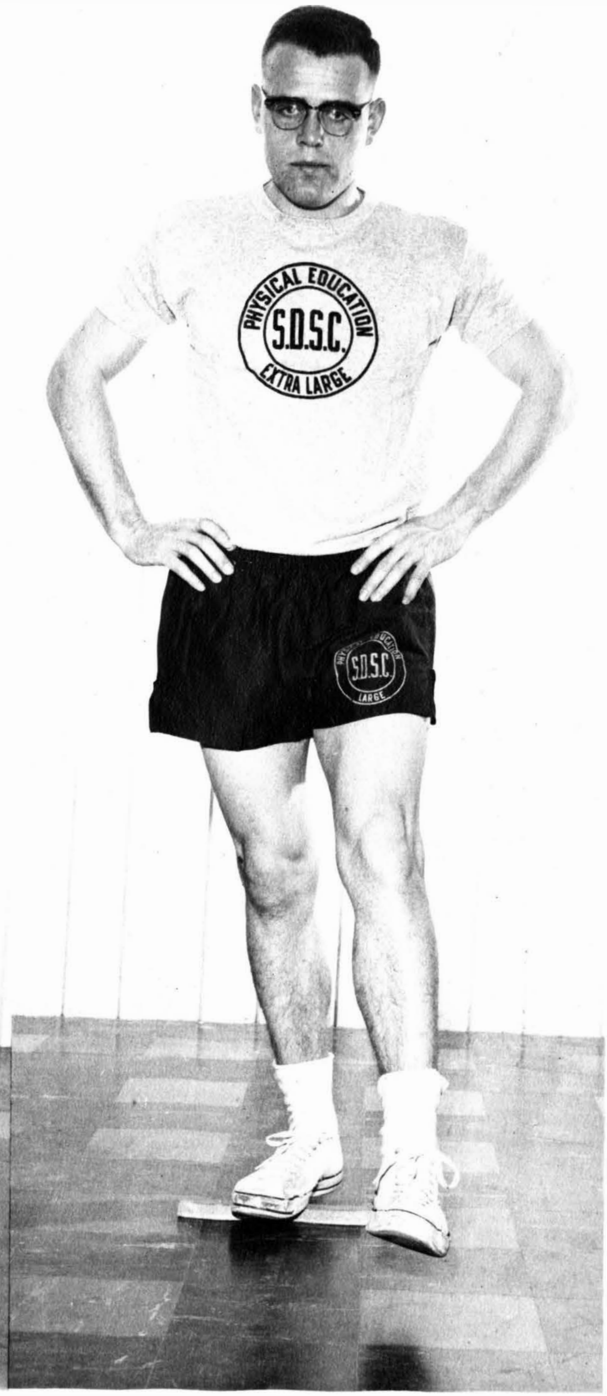

Figure II. Crosswise
Stick Test

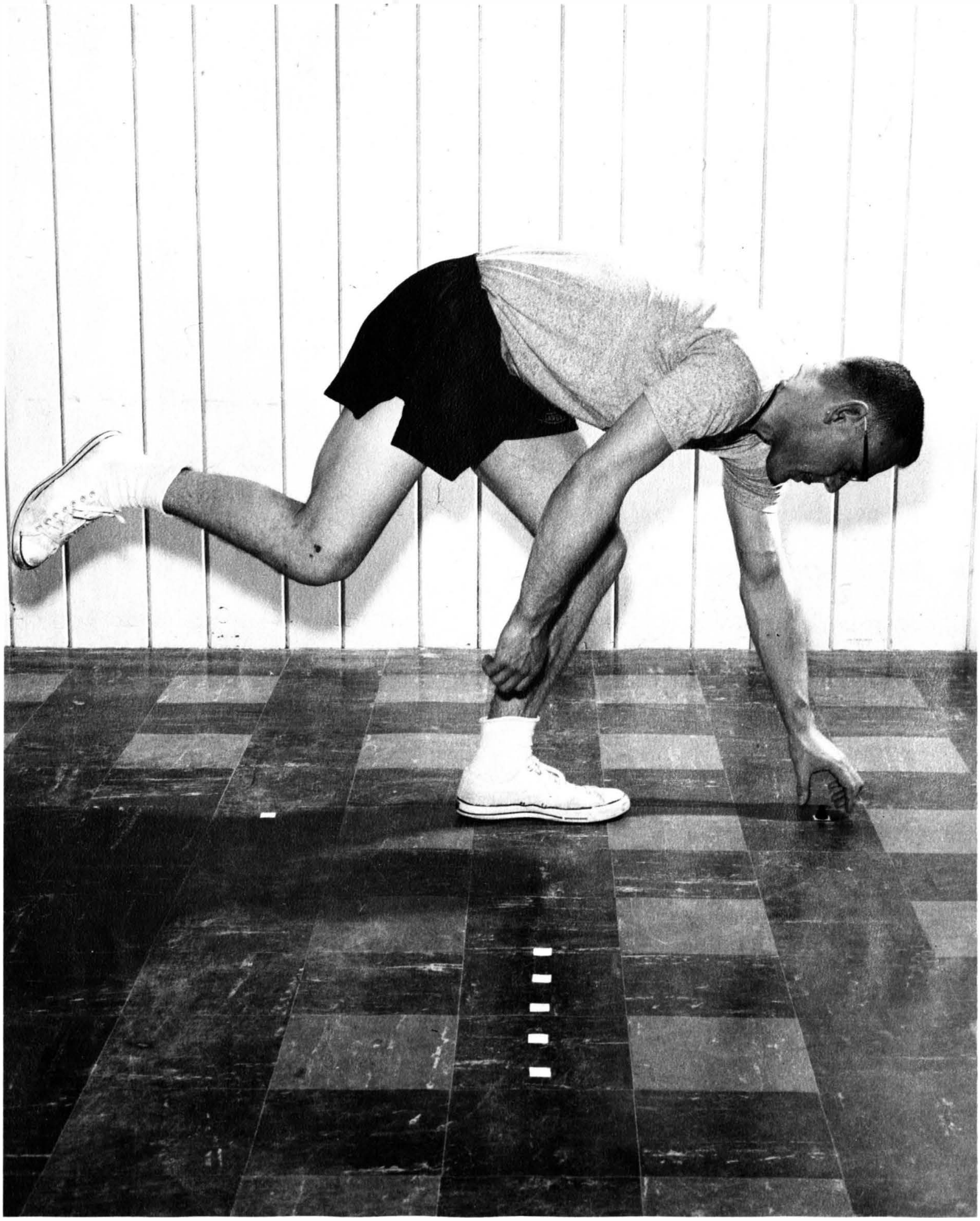

Figure III. Sideward Leap Test

The tests were administered in the following order:

1. Lengthwise Stick Test with glasses
2. Crosswise Stick Test with glasses
3. Lengthwise Stick Test immediately after removal of glasses
4. Crosswise Stick Test immediately after removal of glasses
5. Sideward Leap Test with glasses
6. Sideward Leap Test immediately after removal of glasses
7. Lengthwise Stick Test after eye adjustment without glasses
8. Crosswise Stick Test after eye adjustment without glasses
9. Sideward Leap Test after eye adjustment without glasses

Following the administration of the Sideward Leap Test, immediately after removal of glasses, the subjects waited 25 minutes during which their eyes were permitted to adjust to the light without the glasses. The tests following this adjustment period were taken without the aid of glasses.

Because of the nature of this study, the author wanted the subjects as near to peak performance in balance as possible before the actual administration of the balance tests. The author wanted all the learning to take place before the testing; therefore the subjects were allowed several practice trials to become familiar with each of the tests. The number of trials ranged from four to seven depending upon when the subjects felt they were ready to be tested.

The sticks for the Stick Tests were marked on the bottom, and the floor was marked denoting the perimeter of the stick. Before each trial, the stick was placed with the marked side down in the area marked on the floor.

The subjects wore gym shoes and comfortably fitting clothes during the testing period. A damp towel was provided for wiping off the shoes before taking the Sideward Leap Test.

Scoring of Tests

Each Lengthwise and Crosswise Stick Test involved six trials, with the number of seconds balanced on each trial being totaled for each individual test score. Seconds were recorded to the nearest tenth.

The Sideward Leap Test was made up of 12 trials —— three on the left foot, three on the right foot, three on the left foot, and three on the right foot. Each trial was recorded to the nearest tenth of a second, unless a failure resulted. A failure was recorded as an "F" and counted as zero seconds. The number of seconds for each trial was totaled for each individual test score. See Appendix B for description of failures.

CHAPTER IV

TREATMENT AND ANALYSIS OF THE DATA

Introductory Statement

The basic purpose of this study was to determine the effect of the use of glasses on the balance of athletes who wear glasses. The statistical methods used were the calculations, from the test scores obtained, of the differences between the means and the significance of these differences.

The experimental design used in this study was the "single group method" in which the differences between the means were computed from the raw scores of the same tests given to each one in the same group, performing with glasses, immediately after removal of glasses, and after a 25-minute period of eye adjustment without glasses. Because the number of subjects in the group participating in this study was small, the following formula for the computation of the t value was used.[39]

$$SD = \sqrt{\frac{x^2}{(N - 1)}}$$

$$SE_D = \frac{SD}{\sqrt{N}}$$

$$t = \frac{M_D - 0}{SE_D}$$

Interpretation of Results

To test the differences obtained for significance, Table D in Garrett[40] was used. The degrees of freedom (N-1) were determined for each comparison. The t value at the 5 per cent level of confidence was accepted for this study, and the null hypothesis applied in each case. The group in this study was made up of 27 individuals. This group had 26 degrees of freedom which made the t value at the 5 per cent level of confidence 2.06.

Following is a legend for the tests used during this study:

Test 1A--Lengthwise Stick Test with glasses

Test 2A--Lengthwise Stick Test immediately after removal of glasses

Test 3A--Lengthwise Stick Test after eye adjustment without glasses

Test 1B--Crosswise Stick Test with glasses

Test 2B--Crosswise Stick Test immediately after removal of glasses

Test 3B--Crosswise Stick Test after eye adjustment without glasses

Test 1C--Sideward Leap Test with glasses

Test 2C--Sideward Leap Test immediately after removal of glasses

Test 3C--Sideward Leap Test after eye adjustment without glasses

In the tables which follow the tests will be referred to by their corresponding numbers in the legend.

Referring to Table 1, one can readily see that the decrease in

Table 1. Difference between the Means, Standard Error of the Difference, and the t Value Computed from the Test Scores of the Lengthwise Stick Test with Glasses and Immediately after Removal of Glasses

Test 1A	Test 2A	Difference (M 1A - M 2A)	SE_{DIFF}	t	Level
5514.3	4977.6	19.88	13.71	1.45	none

balance from the Lengthwise Stick Test with glasses to the Lengthwise Stick Test immediately after removal of glasses was not significant at the 5 per cent level of confidence. The null hypothesis was accepted for this part of the study.

In Table 2 the results of the Lengthwise Stick Test with glasses and after eye adjustment without glasses are recorded. The data show

Table 2. Difference between the Means, Standard Error of the Difference, and the *t* Value Computed from the Test Scores of the Lengthwise Stick Test with Glasses and after Eye Adjustment Without Glasses

Test 1A	Test 3A	Difference (M 1A - M 3A)	SE_{DIFF}	*t*	Level
5514.3	6124.9	-22.61	16.68	-1.35	none

that there was an increase in balance on the Lengthwise Stick Test after eye adjustment compared to the balance on the Lengthwise Stick Test with glasses. However, this increase was not significant at the 5 per cent level of confidence. The null hypothesis was applied and accepted for this comparison.

The results of the Lengthwise Stick Test given immediately after removal of glasses and after eye adjustment without glasses were compared in Table 3. The increase in balance after eye adjustment without glasses over balance immediately after removal of glasses was significant at the 5 per cent level of confidence as is shown in Table 3. The null hypothesis was applied and rejected for this comparison. The increase in balance was accepted as real.

Table 3. Difference between the Means, Standard Error of the Difference, and the t Value Computed from the Test Scores of the Lengthwise Stick Test After Eye Adjustment Without Glasses and Immediately after Removal of Glasses

Test 3A	Test 2A	Difference (M 3A - M 2A)	SE_{DIFF}	t	Level
6124.9	4977.6	42.49	10.68	3.98	5%

In Table 4 the results of the Crosswise Stick Test with glasses were compared to the results of the Crosswise Stick Test immediately after removal of glasses. Although the results of the Crosswise Stick Test

Table 4. Difference between the Means, Standard Error of the Difference, and the t Value Computed from the Test Scores of the Crosswise Stick Test with Glasses and Immediately after Removal of Glasses

Test 1B	Test 2B	Difference (M 1B - M 2B)	SE_{DIFF}	t	Level
1956.6	1552.6	14.96	8.62	1.73	none

immediately after removal of glasses showed a decrease in balance from the results of the Crosswise Stick Test with glasses, this decrease was not significant at the 5 per cent level of confidence. The null hypothesis, which was applied to this comparison, was therefore accepted.

Table 5 indicated that the degree of balance during the Crosswise Stick Test with glasses was greater than balance during the Crosswise Stick Test after eye adjustment without glasses. This difference, however, was very small and was not significant at the 5 per cent level of confidence. After applying the null hypothesis to the comparison, it was accepted.

Table 5. Difference between the Means, Standard Error of the Difference, and the t Value Computed from the Test Scores of the Crosswise Stick Test with Glasses and after Eye Adjustment Without Glasses

Test 1B	Test 3B	Difference (M 1B - M 3B)	SE_{DIFF}	t	Level
1956.6	1900.8	2.07	9.43	.22	none

Table 6 shows that the ability to balance during the Crosswise Stick Test after eye adjustment without glasses was significantly better

Table 6. Difference between the Means, Standard Error of the Difference, and the t Value Computed from the Test Scores of the Crosswise Stick Test after Eye Adjustment Without Glasses and Immediately after Removal of Glasses

Test 3B	Test 2B	Difference (M 3B - M 2B)	SE_{DIFF}	t	Level
1900.8	1552.6	12.90	5.70	2.26	5%

than the ability to balance during the Crosswise Stick Test immediately after removal of glasses. The t value obtained was 2.26 which was large enough to be significant at the 5 per cent level of confidence. The null hypothesis was applied and rejected. The gain in balance was therefore accepted as real.

Table 7 indicates the subjects scored higher during the Sideward Leap Test with glasses than they did immediately after removal of glasses. However, this increase was so small that it lacked significance at the 5 per cent level of confidence. The null hypothesis was accepted.

Table 7. Difference between the Means, Standard Error of the Difference, and the t Value Computed from the Test Scores of the Sideward Leap Test with Glasses and after Eye Adjustment Without Glasses

Test 1C	Test 2C	Difference (M 1C - M 2C)	SE_{DIFF}	t	Level
1185.9	1115.8	2.60	1.46	1.78	none

Table 8 directs attention to the fact that on the Sideward Leap Test the subjects balanced better while wearing glasses than after the eye adjustment period without glasses. The t value arrived at for this

Table 8. Difference between the Means, Standard Error of the Difference, and the t Value Computed from the Test Scores of the Sideward Leap Test with Glasses and after Eye Adjustment Without Glasses

Test 1C	Test 3C	Difference (M 1C - M 3C)	SE_{DIFF}	t	Level
1185.9	1117.8	2.52	1.96	1.28	none

comparison was 1.28. This did not meet the required 2.06 for a level of significance at the 5 per cent level of confidence. Therefore, the null hypothesis, which was applied to this comparison, was accepted.

The results of the Sideward Leap Test, taken immediately after the removal of glasses by the subjects and after eye adjustment without glasses, are found in Table 9. The subjects balanced an insignificantly

Table 9. Difference between the Means, Standard Error of the Difference, and the *t* Value Computed from the Test Scores of the Sideward Leap Test after Eye Adjustment Without Glasses and Immediately after Removal of Glasses

Test 3C	Test 2C	Difference (M 3C - M 2C)	SE_{DIFF}	*t*	Level
1117.8	1115.8	.07	1.93	.04	none

longer time after the eye adjustment period than immediately after removal of glasses. After applying the null hypothesis to this comparison, the author accepted the null hypothesis.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The basic purpose of this study was to determine the effect of wearing or of not wearing glasses on the balance of bespectacled athletes. This study was accomplished by selecting three previously validated tests of balance and by administering them to 27 bespectacled varsity and freshman athletes. These tests were administered during one testing period. The subjects took each test with glasses, immediately after the removal of glasses, and again without glasses after an eye adjustment period. A total of nine tests of balance was given to each subject. The results of each test given under the various conditions were compared and the null hypothesis applied.

Conclusions

The following conclusions were drawn from the data presented in this study.

1. Wearing of glasses showed no significant increase or decrease in static balance over not wearing glasses, as measured by the Lengthwise and Crosswise Stick Tests.

2. An increase in static balance, significant at the 5 per cent level of confidence, was found after eye adjustment without glasses in contrast to balance immediately after removal of glasses, as measured by the Lengthwise and Crosswise Stick Tests.

3. The wearing of glasses showed no significant increase in the dynamic balance of the subjects over not wearing glasses, as measured by the Sideward Leap Test.

4. Eye adjustment without glasses resulted in no significant increase in dynamic balance over dynamic balance immediately after removal of glasses, as measured by the Sideward Leap Test.

Recommendations

1. The present study should be repeated using a larger sample, either to substantiate or refute the findings of this study.

2. The present study should be repeated using additional tests to study balance. The Balance Beam Test and the Stepping Stone Test are tests of balance which could be employed.

3. Additional research should be conducted to determine to what degree the factor of learning affects the testing of balance.

4. In view of the findings in this study, an athlete who does not wear his glasses during an athletic contest should remove his glasses for a period of time before participation to allow his eyes to adjust adequately and thereby permit the athlete to attain his maximum balance during his performance in the athletic contest.

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APPENDIX A

Description of Stick Tests

A stop watch and a stick 1 inch high, 1 inch wide, and 12 inches long were used for measuring static balance. In order to be consistent, the stick was marked on one side and placed in an area on the floor marking the perimeter of the stick.

Each subject balanced on the stick in two different positions in relation to his foot. During the Lengthwise Stick Test the subject stood erect on one foot, with the stick running lengthwise down the middle of the supporting foot. During the Crosswise Stick Test the subject stood erect with the stick crosswise under the ball of his foot.

Directions were similar for both tests; the only difference involved the change in position of the stick. Each subject was instructed to stand on the stick with his dominant foot. Hands were to be placed on the hips and the other foot was free. This position was then demonstrated.

After the subjects had had several practice trials, the test was administered. Before each trial a preparatory command of "Ready" was given, followed by the command "Balance," on which the free foot was raised from the floor. Time was started when the free foot left the floor. Time ceased if an error was made or if one minute had elapsed, whichever was shorter. Errors included moving the hands from the hips, touching of either foot to the floor, and touching the floor with any other part of the body. Each test was given three times, with six trials for each test. Time was recorded to the nearest tenth of a second. The total of the six trials was the score for each particular test.

Raw Data of the Crosswise Stick Test

Subject No.	With Glasses	Immediately without glasses	Adjustment without glasses
1.	29.0	27.9	28.0
2.	62.6	73.6	72.0
3.	164.7	102.9	83.9
4.	29.2	29.1	32.0
5.	15.3	12.6	13.2
6.	130.4	87.1	191.7
7.	93.3	130.0	152.3
8.	160.2	172.3	235.4
9.	64.2	54.4	62.1
10.	100.3	50.2	148.0
11.	219.0	205.0	230.5
12.	27.9	21.5	21.1
13.	20.2	16.3	31.0
14.	39.3	33.8	44.3
15.	32.5	29.8	27.9
16.	46.7	58.8	73.1
17.	17.9	16.2	23.8
18.	14.1	15.2	13.5
19.	18.9	27.9	33.9
20.	97.6	49.5	45.3
21.	28.4	41.8	29.1
22.	111.9	64.1	61.0
23.	98.5	97.1	94.8
24.	252.4	50.4	67.1
25.	28.8	44.2	35.9
26.	24.9	18.3	25.2
27.	28.4	22.6	25.6

Raw Data of the Lengthwise Stick Test

Subject No.	With glasses	Immediately without glasses	Adjustment without glasses
1.	99.6	116.7	58.3
2.	221.1	196.6	321.5
3.	303.0	289.9	322.9
4.	236.6	181.2	287.7
5.	73.7	34.0	97.8
6.	299.0	275.9	307.2
7.	283.5	230.2	213.4
8.	213.0	244.8	360.0
9.	181.6	187.3	269.5
10.	296.1	344.7	339.8
11.	360.0	286.2	360.0
12.	141.7	66.7	127.7
13.	31.8	47.8	129.7
14.	112.2	88.1	223.3
15.	258.7	119.1	77.5
16.	189.0	233.7	304.0
17.	175.6	48.6	97.9
18.	188.1	175.4	166.5
19.	40.5	20.9	26.4
20.	125.1	201.6	192.8
21.	299.3	333.1	340.6
22.	254.7	185.5	285.3
23.	145.8	235.0	351.8
24.	360.0	298.0	291.5
25.	200.0	360.0	319.0
26.	200.8	71.7	99.3
27.	223.8	104.9	153.5

APPENDIX B

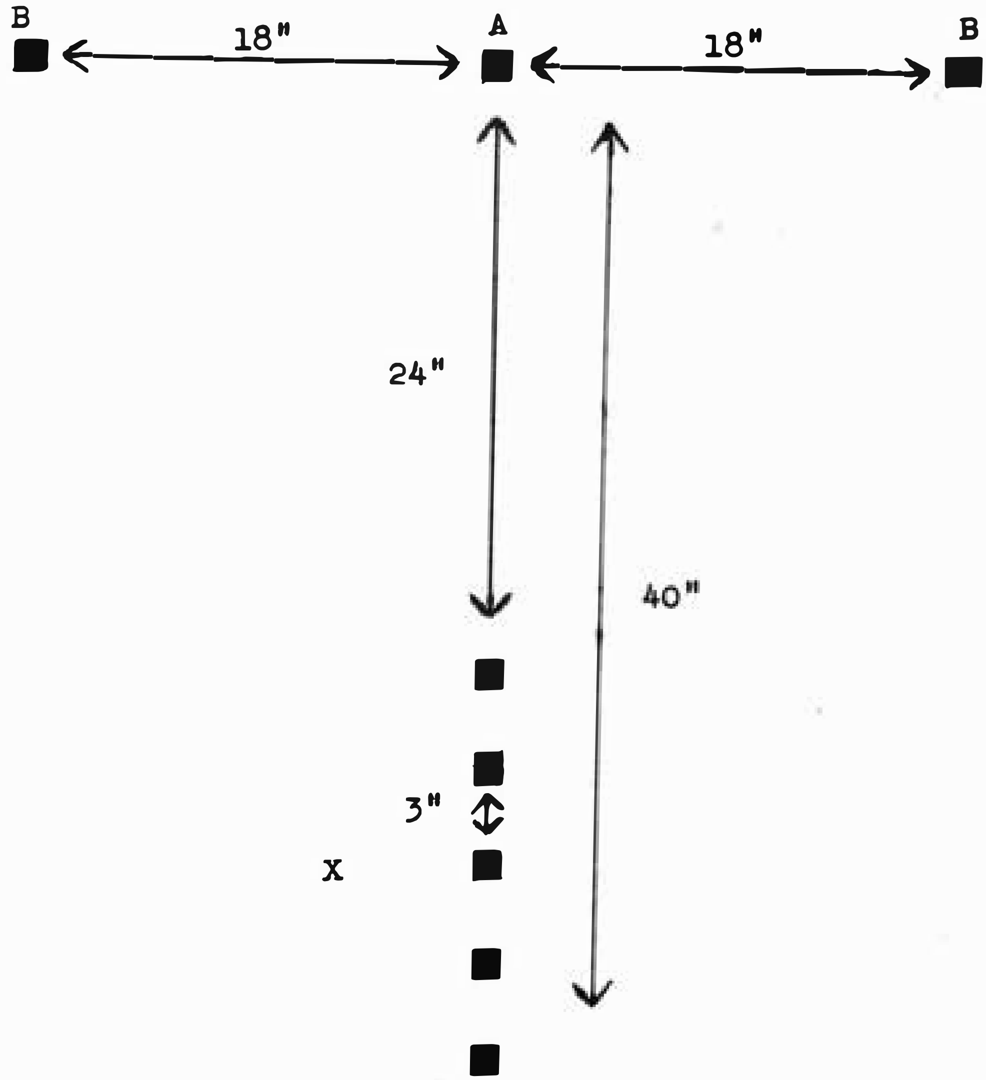
Description of Sideward Leap Test

A stop watch, a football cleat, and a pre-painted floor design for the Sideward Leap Test (Figure IV) were used for the administration of the Sideward Leap Test.

The Sideward Leap Test was prepared by marking three, 1-inch squares in a straight line 18 inches apart. Additional 1-inch squares were placed on the floor in a line at right angles to the previous line. These marks were 3 inches apart and ranged in distance from "A" 24 to 40 inches.

The length of the subject's leg from the hip joint to the floor was measured while the subject remained in a standing position. The subject was instructed to place his right foot on mark "X" which corresponded closest in distance from "A" to leg length; to leap sideward and land on "A" with his left foot; then immediately to lean forward and move the football cleat and hold this position for five seconds. Each trial was performed when the subject was ready without any command from the tester. Time was started as soon as the football cleat was touched by the subject being tested. Each subject was given credit for the number of seconds that he maintained balance to a maximum of five seconds.

A football cleat was used in the administration of the Sideward Leap Test to facilitate the keeping of time for the tester. In the original test the subjects merely touched the floor and lifted their hands off the floor again. It was much easier to see if the cleat moved than if the floor was touched.



X--starting point

A--point of landing on sideward leap

B--point for finger contact with football cleat, right B for leap to left, left B for leap to right

Figure IV. Floor Markings for Sideward Leap Test

A failure for a trial was recorded if the subject (1) failed to cover "A" on the leap, (2) moved the foot after landing, (3) failed to lean forward and move the football cleat immediately, (4) braced the hand on the floor after moving the football cleat, or (5) fell down.

The Sideward Leap Test was administered three times to each subject. Each test consisted of 12 trials—three trials on the left foot, three trials on the right foot, three trials on the left foot, and three more trials on the right foot. A perfect score for each test was 60 seconds.

Raw Data of the Sideward Leap Test

Subject No.	With glasses	Immediately without glasses	Adjustment without glasses
1.	43.4	45.9	38.0
2.	58.0	56.0	57.5
3.	50.5	56.1	55.5
4.	53.9	55.0	59.0
5.	48.2	40.8	40.1
6.	55.8	52.9	56.0
7.	55.7	51.0	56.2
8.	43.9	40.4	42.3
9.	50.0	47.5	22.0
10.	51.1	47.1	46.0
11.	51.4	45.0	47.4
12.	34.1	32.4	26.9
13.	29.6	17.9	32.4
14.	31.2	23.7	18.6
15.	33.4	33.8	36.5
16.	27.3	23.3	43.4
17.	31.4	32.7	31.5
18.	55.9	31.4	55.0
19.	38.0	37.2	46.6
20.	53.4	55.8	51.9
21.	55.0	60.0	60.0
22.	32.2	34.4	19.4
23.	31.4	37.0	40.9
24.	47.1	38.3	26.1
25.	38.7	44.8	34.3
26.	35.5	45.3	46.4
27.	49.8	30.1	27.9