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A Comparison of Muscle Tension and General Motor Ability

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CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS

The motive for this study was the possibility that muscle tension may hamper an individual's ability in those physical skills required for athletics. After conferring extensively with Dr. Harry Lawson concerning his work in the field of podiatry, and with his encouragement, the following study was undertaken.

In athletics, the person who has a great amount of agility is a better athlete than one who suffers muscular tension. For instance, in basketball a person has a better chance of defending an opponent if he can move laterally quickly. In football a person is less apt to suffer an injury if he can physically avoid a direct blow. In baseball a person has to move laterally to field a ground ball or a direct line drive. In track a hurdler has to have flexibility in jumping over the hurdles.

From the preceding, it seems evident that muscle tension plays a vital part in one's ability to perform nearer to his potential.

Muscle tension can be produced by either intrinsic or extrinsic stimulation. These stimuli accumulate, and as the same area of the body is repeatedly affected the muscle loses the ability to relax (14:42).

Hans Kraus and W. Raab state that debilitating conditions besides "softness and flabbiness" result from the lack of sufficient muscular action. "Rigidity, or tightness", and actual shortening of the muscles also result (14:42). When muscles become tighter, and therefore more tense, the range of movement in the joints is restricted, which causes a loss of movement for the individual. Because of this loss of movement, the individual is severely hindered in his ability to perform physical skills. To counter muscle tension and softness of muscles, the athlete must condition the year round.

The potential of an individual can be greatly hampered by his inactivity during off-season play. The muscles will lose their tone and start to atrophy if the individual is inactive. Where physical education is not offered for the eleventh and twelfth grades, the athlete's muscle tone may regress between seasons to the condition at which it was at the beginning of the previous season. Atrophy is slow and the athlete will stay at his attained level for some time, but he will not advance to the next step of development without activity. Coaches must keep their athletes working continually on proper exercises to insure normal maturation as well as provide the advanced development necessary in athletics.

Through conditioning the athlete is able to release his pent-up emotional strain which comes from everyday living. It is also thought that he is better able to cope with daily problems of life.

The importance of trunk-hip flexibility to motor performance is yet to be proved satisfactorily (1:140). The investigator strove to discover a possible relationship between flexibility and general motor ability.

Harry Lawson, D.S.C., states that there is a direct relationship between muscle tension of the lower extremities and flexibility of the trunk-hip joint (17).

It is the intention of this study to show the relationship between muscle tension and motor ability.

The result of this study may prove of value to coaches who have students with muscle tension. They will have a better understanding of the reasons one student cannot perform certain feats while others of lesser stature may perform them easily.

THE PROBLEM

<u>Statement of the problem</u>. The two purposes of this study are (1) to determine the relationship between muscular tension, as evidenced by inward and outward rotation of the lower extremities, and a general motor ability test;

and (2) to determine the relationship between muscular tension as evidenced by hip flexion and a general motor ability test.

Hypothesis tested. The one-tailed hypothesis tested was as follows: Subjects who score high in general motor ability will show significantly less muscular tension than those subjects who score low in general motor ability.

Limitations of the study. This study was limited to the sophomore and junior boys at Cle Elum High School during the fourth quarter of the 1967-68 school year. The subjects were both athletes and non-athletes.

The investigator was unable to control the subjects' outside activities, which may have influenced their participation on the day of the test.

II. DEFINITIONS OF TERMS USED

General motor ability. "General motor ability is the ability of the individual in the elements which underlie motor performance such as strength, muscular power, muscular endurance, coordination, agility, balance." (16:79)

Flexibility. "Range of movement in a joint or sequence of joints." (2:203)

Inward rotation. To plantar flex the foot and turn it inward 180 degrees from the starting position.

<u>Outward rotation</u>. To lock the knee and with the foot dorsal flexed, turn the foot outward to a ninety-degree angle from the starting position.

<u>Starting position</u>. The subject sits in a straight back chair with the leg and foot relaxed, and with the foreleg and foot held parallel with the floor.

<u>Tension</u>. The inability to physically relax a muscle or muscle groups (31:25).

<u>Chins</u>. A horizontal bar is used so that the subject's feet do not touch the floor at any time during this test. The subject uses either the forward or reverse grip. Arms must be straight in the hanging position, and the chin must pass over the bar when pulling up (16:97).

<u>Dips</u>. Parallel bars are set at shoulder height. The subjects jump to an arm-rest position with arms fully extended. They then lower themselves to a ninety-degree bend in the arms and back up to the arm-rest position (16:97).

<u>Vertical jump</u>. Subject stands close to the vertical jump board with both arms extended upward, feet flat on the floor. The scale is set at the height of his maximum reach

at the tip of the fingers for each hand. Subject then stands with either side to the vertical jump board. Subject jumps as high as possible and touches the board at maximum height of jump (16:97).

The remaining chapters will contain literature relevent to this study, methods used, and results. A discussion of the findings will be presented in the final chapter.

CHAPTER II

REVIEW OF RELATED LITERATURE

The American way of life has presented a very serious problem to the people who currently live in its society. It is a sedentary way of living, according to Kraus and Raab, that has rendered relatively inoperative a very important system in our body, "the striated musculature, which constitutes a major part of our body weight and has an important role which exceeds the mere function of locomotion" (14:4). Action of the striated muscle influences directly and indirectly, circulation, metabolism and endocrine balance. It directly affects the structure of our bones, our posture and the position of our bodies. Finally, the striated muscle serves as an outlet for our emotions and nervous responses, the means by which we react and respond to stimuli and emotional stresses.

While at work or at play many people have undue stresses or muscular tensions caused by bad posture in one region or another of the body. This neuromuscular tension can also result from many different sources, such as extra-curricular activities which place too much emphasis on winning, lack of sleep, mental overwork and worry, and the demands of school in general. Although sleep varies as to the need of the individual, one is unable to maintain a high standard of efficiency without this required rest. Fatigue from mental work is slight but menial tasks can goad the body into enduring dangerously close to its potential physical strength. Mental work never results in excessive impairment of the nervous and muscular systems, but brings about the inability to relax. School demands add greatly to a person's frustrations and he is under constant negative stimulation. A real opportunist realizes that the definiteness of a task sets up a challenge with tensions constituting a drive toward completion of that task (21:60). Logical progression of goals is likewise pertinent to task completion, and each man must approach an objective on a level that is least frustrating to him. This is because all are not stubbornly born or even richly born of patience, and many pay a large price for this lack.

An outlet for this built-up tension should be provided by physical education or extra-curricular activities, but all too often they only add to a person's inability to relax. Too much emphasis is placed on winning--not playing the game for the love of it. Furthermore, school work is too often done under the pressure of time. Since much of our daily work in on a speed basis, it is not surprising from a practical standpoint, that hypertension has become such a great problem in our lives during and after school years (21:140).

Pain and tension can be one and the same. The habitual back pain sufferer is a person whose condition is caused by physical inactivity under circumstances which combine lack of exercise with emotional stresses and nervous strain. If a muscle is tensed frequently and not permitted to return to full length, it will shorten permanently. If that muscle is further shortened through stimuli, tension will increase to spasm, and this spasm will actually produce considerable pain (14:42). Exercise has a "protective value" toward indirectly preventing back pain by serving as an outlet for nervous irritations. The large posture muscle groups of the trunk and back are frequently involved in a vicious circle; inactivity, deficiency, tension, pain, more enforced inactivity, etc. (14:9). Flexibility shows a great dependency upon tension, whether caused by psychological problems or outside irritation. The interrelations between flexibility of a muscle and its tension status is quite evident.

Clinical evidence points to the fact that the absence of minimum muscular efficiency (i.e. basic fitness) tax the person's ability to meet everyday functional requirements. Any sudden activity or any unusual demand, whether physical or emotional, may precipitate acute or chronic derangement. Lack of exercise significantly contributes to the development of functional and degenerative changes of the heart muscle, and possibly of the arterial system. Further, neurovegitative biochemical factors are fundamentally responsible for these widely-occuring disasterous processes in a general atmoshpere of, "take-it-easy-ism" (14:27). The resulting inferiority of our muscular development was first demonstrated statistically in 1956 when physical fitness tests devised by Drs. Hans Kraus and Sonya Weber were applied to American and European children (13).

I. RELATIONSHIP BETWEEN TENSION AND RANGE OF MOTION

Kraus and Raab found that flexibility of a muscle and the tensions of a person are quite evident whether caused by psychological problems or outside irritations (14:18-19).

Morehouse and Miller also state that mental and emotional experience affect tension (29:68).

Cureton found by applying flexibility exercises to young men of college age that some were able to relax their antagonistic muscles better than others, giving them a larger range of movement (5:382).

Larson and Yocom state that a highly-flexible individual spends less energy in accomplishing skills than a less flexible individual who, with a great expenditure of energy, may or may not make the necessary skill adjustments (16:160).

Kraus and Raab categorized people as sedentary versus physically active. They found that sedentary people are low in flexibility where physically active people are high in flexibility (14:6).

II. RELATIVE CONTRIBUTION OF FLEXIBILITY TO MOTOR SKILL

Cureton states that any attempt to appraise all-around motor fitness should include items from each of the following areas: (1) Balance, (2) flexibility, (3) agility, (4) strength, (5) power; and (6) endurance (6:410).

In a study related to the learning of motor skills, McCloy lists some of the most important factors as: (1) Muscular strength, (2) dynamic energy, (3) ability to change direction, (4) flexibility; and (5) agility (27:32). McCloy also states that learning in many activities is dependent upon the flexibility of muscles, joints and ligaments (27: 32-33).

Larson and Yocom state that the effectiveness of individual adjustments in many physical activities is determined by the degree of total body or specific joint flexibility (16:160).

Cozens used leg flexibility in his battery of tests to measure general athletic ability for college men. According to Clarke, Cozens gave the test elements of jumping strength, leg strength, and leg flexibility a sigma score weighting of .09 out of a total of 7.0. Seven test elements were included (2:276).

Cureton placed trunk flexion at 2.2 per cent contribution to a thirty-item motor fitness criterion. Test item contributions ranged from 22.2 per cent to as low as 0.0 per cent (6:406).

As cited by Cureton, Latham factor analyzed the Illinois Motor Fitness Test battery. His work revealed six basic factors in the overall appraisal of motor fitness: (1) Endurance, (2) strength, (3) balance, (4) agility, (5) power; and (6) flexibility.

By testing four Japanese swimmers who broke the world 880-yard relay record by 38 seconds, Cureton found that they averaged 31.3 per cent better on trunk flexion than the American team members (5:384).

Matthews and his co-workers studied hip flexibility of college women and elementary school boys as related to length of body segments (25)(26). In each instance no significant relationship was found between flexibility of the hip joint and length of body segments. Examination of the extremes of the distribution of lower limb length seems to support the hypothesis that flexibility is independent of lower limb length.

Bovard and Cozens state that the whole crux of the testing situation is that whatever is done shall hold the interest of the person tested and stimulate him to take better care of himself (1:72).

III. SELECTION OF A GENERAL MOTOR ABILITY TEST

Larson's Muscular Strength Test was used to test general motor ability. Larson's test consists of three items; (1) chinning, (2) dipping, and (3) vertical jump (16:97). The validity of Larson's test in predicting motor ability was reported by the National Research Council of the Research Section of the American Association for Health, Physical Education and Recreation. It was found that the items (chinning, dipping and vertical jump) correlate .82 with a fifteen-item composite motor ability criterion. The relationship was obtained with a sample of college men. Similar results were obtained with a group of high school boys (30:121). Also, the Larson test is simple to administer and a great number of subjects can be tested in a relatively short time.

IV. SELECTION OF THE SCOTT-FRENCH FLEXIBILITY TEST

The Scott-French Bobbing Test was considered by its originators to be a measure of the flexibility of the hip and back (or trunk). It was selected principally because of its reliability and its specific applicability to the joint area in question. According to Clarke, Foley obtained a reliability coefficient of .93 for the standing-bobbing test, with college women as subjects (2:139).

V. TESTING FOR TENSION

Rathbone tests the muscles controlling the wrist elbow, shoulder, ankle, knee and hip joint, as well as those of the neck, while the subject is completely relaxed. In so doing, she is able to get a satisfactory judgment of the degree and extent of residual hypertonus (i.e., muscle tension) which is present in the individual (31:135).

Jones used the straight line test to test for tension. In performing this test, the subject removes all foot and leg coverings to a point just above the knee. With a pen the examiner draws a straight line down the front of the leg from above the knee to the ankle joint and continues this straight line down the dorsum of the foot to a point between the second and third toes dividing the foot equally. The foot is slowly rolled toward its inner border. Movement is noted along the whole lower leg by the line curve. The foot is then turned towards its outer border and the reverse movement is noted.

Lawson tests for muscle tension through the lower extremities. He states that muscle tension is divided into two types, lateral and medial. Lateral tension is the inability to extend the foot and to rotate it inward and downward until the toes point directly to the floor while in a sitting position. Medial tension is the inability to hold the knee down and to rotate the foot outward ninety degrees while sitting.

Lawson manually manipulates subjects' feet, and subjectively records the amount of tension as either 100 per cent, 75 per cent, 50 per cent, 25 per cent, or no tension (18).

VI. THE FOOT

Massage and manipulation of the feet is one of the most restful and relaxing procedures in a trainer's "bag of tricks". Quite often a five-minute massage will revive an apparently exhausted athlete (3:1).

Inman states that many of the foot movements have not been adequately reported on (11). Rotation in the lower extremities occurs when the foot is firmly placed on the floor. The degree of rotation progressively increases in magnitude from the proximal to the distal end. "During normal walking on level ground the pelvis rotates 6 degrees, the femur 13 degrees and the tibia 18 degrees." (23)

Mann and Inmann point out an intimate relationship exists between rotation and intrinsic muscle activity. Muscle activity in this sense is not the activity necessary to support the arches of the fully-loaded feet at rest. External rotation of the tibia causes movement of the talus, which in turn transmits sufficient force to the transverse tarsal joint to raise the arch without direct use of muscle power (22:471).

CHAPTER III

METHODS AND PROCEDURES

The original motive behind the undertaking of this study was to determine the influence of muscle tension upon the performance of a general motor ability test. Lawson's Lower Extremity Test for Muscle Tension (18) and Larson's Muscular Strength Test (16) were chosen to test this relationship.

Pearson product-movement correlation was employed to indicate the relationship between muscle tension and a general motor skills test. It was also decided that a voluntary rotation of the lower extremities should be added to the test battery. This differed from Lawson's technique in that the movement was made by the subject and not the tester.

A third variable, hip flexibility--as measured by the Scott-French Test--was also introduced to determine its relationship to the general motor ability test and establish the relationship between it and the Lawson Test. Therefore, the first purpose of this study was to determine the correlation between (1) Lawson's involuntary muscle tension test and general motor ability, (2) Lawson's voluntary muscle tension test and general motor ability; and (3) the Scott-French hip flexibility test and general motor ability.

The Lawson Test. A means was needed to test the flexibility of the lower extremities. After talking with Dr. Harry Lawson, his test was selected. He proposed a method of checking for muscle tension by rotating the feet both inward and outward. When subjectively noting the amount of resistance to this test, he is able to diagnose the amount of muscle tension a person possesses. By using a taping technique over a period of time, he is able to relieve a person of this muscle tension permanently.

Tension Instrument for Flexibility of the Lower Extremities. A device was needed for determining the amount of rotation of the lower extremities according to the Lawson technique for testing muscle tension. A machine was so constructed that it removed the variables related to the free-hand method. Dr. Lawson's professional opinion was that the machine would test what it was designed to test.

The device was constructed of a piece of three-fourth inch plywood cut into a twenty-two inch circle. A one-half inch by six inch carriage bolt was inserted through a hole drilled in the center of the circle. A steel heel plate was constructed with two foot guides extending outward to enclose the inner and outer borders of the foot. A hole in the heel plate allowed the carriage bolt to pass through its center, also. A one inch by four inch cylindrical piece of wood attached to the heel plate raised the plate four inches off the face of the plywood to allow the foot to be plantar flexed. A narrow strip of tin with a hole in one end to allow the bolt to pass through was used as a marker. This marker was mounted behind the plywood with only the point showing over the edge. The marker was so fastened to the bolt (with a wingnut) that both rotated together when the heel plate turned. This enabled the tester to adjust the marker to any position he desired and to record the number of degrees the foot would rotate. The stand was made of steel fastened to the plywood, allowing the face to be perpendicular to the ground.

The face of the machine was divided into five-degree segments. Readings indicated the number of degree segments covered.

Procedure. The subject sits in a straight back chair and places his heel in the heel plate of the testing device. He then relaxes his lower extremities. The tester sets the gauge at zero and places the second toe in line with zero. The side plate is placed snugly along the border of the foot. For inward rotation the inside border of the foot is used. For outward rotation the outside border of the foot is used. The tester can then test the subject for inward and/or outward rotation, depending upon the initial setting.

On inward rotation the tester would (1) set the machine for proper rotation; (2) plantar flex the subject's foot; (3) hold the heel snugly in place; (4) push the subject's foot as far as possible without having the subject's hips rise from the chair; (5) read the degree of rotation; and (6) record the reading.

On outward rotation the tester would (1) set the machine for testing the proper rotation; (2) dorsal flex the subject's foot; (3) hold the knee down in a locked position; (4) rotate the subject's foot to resistance; (5) read the degree of rotation; and (6) record that reading.

The subject is then allowed to voluntarily rotate his own feet inward and outward while his heel--and knee in outward rotation--is held in place by the tester. The marker readings are recorded.

Reliability of the Tester. Tests were given to fifteen trial subjects for the following involuntary movements:

1. Inward rotation of the right foot on the testing machine.
2. Outward rotation of the right foot on the testing machine.
3. Inward rotation of the left foot on the testing machine.

4. Outward rotation of the left foot on the testing machine.

The fifteen subjects were retested the following day on the same test items. The data obtained was then correlated to find the reliability of the tester to perform the same test accurately.

The results were as follows:

1.	Inward rotation of the right foot	.956
2.	Outward rotation of the right foot	.985
3.	Inward rotation of the left foot	.948
4.	Outward rotation of the left foot	.802

Larson Muscular Strength Test. The Larson Muscular Strength Test (16:97) was chosen for testing the general motor ability of the subjects in this experiment. The test included three items: (1) Chins, (2) dips; and (3) vertical jumps. The subjects were tested according to Larson's technique on each item. Larson's test proved to be easily administered to a large number in a short period of time.

The subjects were first given the test for chins. They were allowed a ten-minute rest period before going to the next test item--dips. The third test item varied from Larson's in that the subject was given five trial jumps and the mean score for the five jumps was recorded (10:28). This differed from the standard test in that Larson administered only three jumps and the maximum distance was recorded.

According to Larson, Bookwalter found that these three items correlate with a large motor ability criterion at approximately .85 (16:86).

The items in Larson's test of chinning, dipping and vertical jumping are so commonly used in physical education classes that it was not necessary to check for tester reliability (4).

<u>Scott-French Bobbing Test</u>. The Scott-French Bobbing Test was chosen to test the amount of hip flexibility the subjects possessed (2:139).

The measuring instrument was a piece of one-fourth inch plywood cut four inches wide and twenty inches long. The board was calibrated in one-half inch segments with zero in the center, and plus and minus ten inches on the bottom and top, respectively. The board was fastened vertically to a wooden bench with the zero level on its top surface.

The subjects stood on the bench when taking the test and placed their feet on either side of the board. Then, keeping the knees straight, they bent forward, touching the fingers of both hands on the front surface of the testing board. The investigator then read the maximum measurement to which the subjects could reach while bobbing up and down.

The score was then recorded with a plus or minus, depending upon the score made. Plus values were given to all numbers below zero, and minus values were given to those numbers above zero. Each subject was allowed four trials.

The test was found to be easy to administer, and it allowed a large number of subjects to be tested in a short time. The reliability of the tester for the Scott-French test was .976. Fifteen subjects were used in the test/re-test.

<u>Administration of the Tests</u>. The Larson, Lawson, and Scott-French tests were administered to sixty-three sophomore and junior boys at Cle Elum High School.

The subjects were first given the Lawson Muscle Tension Test of the Lower Extremities. The procedure was as follows:

1. Right leg
   A. Inward rotation
   B. Outward rotation

2. Left leg
   A. Inward rotation
   B. Outward rotation

As previously stated, the Lawson test was also varied to establish the predictability between the two methods. The new method varied only in that the subject voluntarily rotated his own foot inwardly and outwardly while the tester held the leg in its proper position. Directly following the standard Lawson Muscle Tension Test, mentioned above, the subjects were given the voluntary Lawson test. The same order for testing the lower extremities was followed.

The subjects were then administered the Scott-French Bobbing Test. Thirty minutes were allowed between the two tests. The tester held the subject's knees with one hand to make sure they were not bending. The tester's other hand was opened with the fingers held perpendicular to and touching the measuring scale. As the subject bobbed, he forced the tester's hand downward with his own hands. After the fourth trial the score was recorded.

Twenty-four hours elapsed before the administration of Larson's battery of tests. Larson's procedure of administering the test was followed.

During the chinning exercise the tester placed his arm across the subject's legs to prevent them from swinging. The investigator also made sure that the subject's arms were fully extended each time, and that his chin passed over the bar.

In performing the dips, the tester placed one arm on the subject's legs to prevent them from swinging. The other arm was positioned under the subject's right shoulder so that the subject had to form a right angle at the elbow in order to contact the tester's fist with each dip. Dips not completed were not counted.

To perform the vertical jump, the zero line of the scale was set at the highest point reached by the subject while standing with both arms evenly extended. The subject was not allowed a preparatory hop before jumping. The investigator recorded all five jumps, and the mean of these was the final score.

Scoring of the Larson test was accomplished by means of conversion tables. First, each raw score was converted to an equivalent weighted score determined by Larson from regression analysis. The sum of the weighted scores for the three test items produced an index score. Second, each boy was classified by age and body size by means of McCloy's "classification index", consisting of regression weightings based on age, height and weight (28:58-60). After determining which of eight classification groups a boy belonged in, his achieved Larson score total was rated against a one hundred-point scale devised by Bookwalter (16:476-477).

Chapter IV presents the analysis of data; and Chapter V, the summary and conclusions along with recommendations for further study.

CHAPTER IV

RESULTS OF THE STUDY

The purposes of this study were (1) to determine the relationship between muscular tension as evidenced by the Lawson technique and Larson's general motor ability test; and (2) to determine the relationship between muscular tension as evidenced by the Scott-French Bobbing Test and Larson's general motor ability test, the hypothesis being that the subjects who score high in general motor ability will show significantly less muscular tension than those who score low in general motor ability.

For each of the purposes a description is presented of the procedure followed, with the findings which resulted. Tables are provided and explained as related to the purpose for which each was calculated. Finally, a summary statement of the results as a whole concludes the chapter.

I. CORRELATIONS

All correlations in the study were computed by machine correlation technique using the following formula suggested by Garrett (8:142):

$$r = \frac{\Sigma XY - NM_X M_Y}{\sqrt{[\Sigma X^2 - N(M^2_X)][\Sigma Y^2 - N(M^2_Y)]}}$$

Pearson product-movement correlations were calculated for the variables shown below, with the results as noted:

Whole Group (N=63)

1. Right foot inward voluntary with general motor ability: r=.11

2. Right foot outward voluntary with general motor ability: r=.13

3. Left foot inward voluntary with general motor ability: r=.16

4. Left foot outward voluntary with general motor ability: r=.29

5. Right foot inward involuntary with general motor ability: r=.05

6. Right foot outward involuntary with general motor ability: r=.05

7. Left foot inward involuntary with general motor ability: r=.13

8. Left foot outward involuntary with general motor ability: r=.16

9. Scott-French Bobbing Test with general motor ability: r=.015

It can be seen that the correlations are extremely small. By referring each correlation to a table indicating significance levels at the .05 and .01 levels of confidence for varying numbers of variables and degrees of freedom, it may also be noted that only one correlation was significantly different from zero. Inspection of this table (9:609-610) shows that for a correlation to be significant at the .05 level of confidence, it would have to be .25. Only left foot outward voluntary with general motor ability (.29) proved to be of any significance.

For the preceding correlations to be significant at the .05 level of confidence, the following number of paired observations would be required (9:610):

.11 = 300 paired observations

.13 = between 200 and 300 paired observations

.16 = between 125 and 150 paired observations

.29 = between 40 and 45 paired observations

.05 = more than 1,000 paired observations

.05 = more than 1,000 paired observations

.13 = between 200 and 300 paired observations

.16 = more than 150 paired observations

.015 = more than 1,000 paired observations

To summarize the discussion of the preceding correlations, it may be concluded that those correlations indicating relationship between Scott-French and Lawson tests with general motor ability were positive, but very small, and, with one exception, insignificant.

II. CORRELATIONS AND TESTS OF SIGNIFICANCE BETWEEN GROUPS

The sixty-three subjects in this study were arbitrarily divided into three categories: (1) High motor ability, (2) middle motor ability; and (3) low motor ability containing twenty-one, twenty-two and twenty subjects respectively, resulting from a rank-ordered listing of the scores from Larson's general motor ability test. Those subjects with scores of seventy-six to one hundred points were the high motor ability group, those with scores of sixty-two to seventy-five comprised the middle motor ability group, and those with scores of thirty-nine to sixty-one made up the low motor ability group.

In order to determine whether these groups, so constituted, were actually from different motor ability populations, it was necessary to test for the significance of difference between means by use of the _t_-test. Table I shows that the differences between the means of these groups were statistically significant at the .05 level of confidence or better. Thus it may be concluded that a rational basis existed for testing the one-tailed hypothesis that high motor ability groups will show significantly less tension, as shown by the Lawson and Scott-French tests, than those who are low in general motor ability.

For a _t_ to be significant at the .05 level of confidence for thirty-nine, forty, and forty-one degrees of freedom, the _t_ would have to be 2.02 (8:449). All _t_'s are significant beyond the .05 level of confidence. Therefore, we are justified in considering motor ability groups different and can test for significance of difference

TABLE I

SIGNIFICANCE OF DIFFERENCE BETWEEN MEANS
OF ARBITRARILY CONSTITUTED GENERAL MOTOR ABILITY GROUPS

High	Middle	Low	Diff.	SE_D	df	t	Probability
85.71	67.59		18.12	8.72	41	2.08	$>.05$
85.71		51.25	34.46	9.52	39	3.62	$>.01$
	67.59	51.25	16.34	7.59	40	2.16	$>.05$

between r's, which resulted from their respective relationships with the Lawson and Scott-French tests.

High Motor Ability. Twenty-one subjects were classified as being high in general motor ability. Their scores ran from seventy-six to one hundred. The distributions of scores made in the Lawson and Scott-French tests were correlated with Larson's Muscular Strength Test (general motor ability). The results were as follows:

1. Right foot inward voluntary with general motor ability r= -.23
2. Right foot outward voluntary with general motor ability r= .36
3. Left foot inward voluntary with general motor ability r= .15
4. Left foot outward voluntary with general motor ability r= .08
5. Right foot inward involuntary with general motor ability r= -.18

6. Right foot outward involuntary with general motor ability r= .16

7. Left foot inward involuntary with general motor ability r= -.23

8. Left foot outward involuntary with general motor ability r= .09

9. Scott-French Bobbing Test with general motor ability r= -.078

The following table shows the significance of the r's for the high general motor ability group.

TABLE II

SIGNIFICANCE OF THE r'S FOR THE HIGH MOTOR ABILITY GROUP: df=19

No.	r's	Significant	Insignificant
1.	-.23		x
2.	.36		x
3.	.15		x
4.	.08		x
5.	-.18		x
6.	.16		x
7.	-.23		x
8.	.09		x
9.	-.078		x

For the r's of the high general motor ability group to be significant at the .05 level of confidence, a correlation of .433 is required for nineteen degrees of freedom. All the r's in this group are small and insignificant.

Middle Motor Ability. Twenty-two subjects were classified as being average in general motor ability. Their scores ranged from sixty-two to seventy-five on Larson's test. The distributions of scores made on Lawson's test and the Scott-French test were correlated with Larson's Muscular Strength Test (general motor ability). The results were as follows:

1. Right foot inward voluntary with general motor ability r= .14
2. Right foot outward voluntary with general motor ability r= .003
3. Left foot inward voluntary with general motor ability r= .12
4. Left foot outward voluntary with general motor ability r= .22
5. Right foot inward involuntary with general motor ability r= .099
6. Right foot outward involuntary with general motor ability r= .076
7. Left foot inward involuntary with general motor ability r= .053
8. Left foot outward involuntary with general motor ability r= .156
9. Scott-French Bobbing Test with general motor ability r= -.06

The following table shows the significance of the r's for the middle motor ability group.

TABLE II

SIGNIFICANCE OF THE r'S FOR THE MIDDLE MOTOR ABILITY GROUP: df=20

No.	r's	Significant	Insignificant
1.	14		x
2.	.003		x
3.	.12		x
4.	.22		x
5.	.099		x
6.	.076		x
7.	.053		x
8.	.156		x
9.	-.06		x

For the r's to be significant at the .05 level of confidence a correlation of .423 is required for twenty paired observations. All the r's in this group are small and insignificant.

Low Motor Ability. Twenty subjects were classified as being low in general motor ability. Their scores ranged from thirty-nine to sixty-one on Larson's test. The distributions of test scores made on Lawson's test and the Scott-French test were correlated with Larson's Muscular Strength Test (general motor ability). The results were as follows:

1. Right foot inward voluntary with general motor ability r= .31

2. Right foot outward voluntary with general motor ability r= -.38

3. Left foot inward voluntary with general motor ability r= .34

4. Left foot outward voluntary with general motor ability r= -.19

5. Right foot inward involuntary with general motor ability r= .017

6. Right foot outward involuntary with general motor ability r= -.056

7. Left foot inward involuntary with general motor ability r= .095

8. Left foot outward involuntary with general motor ability r= -.051

9. Scott-French Bobbing Test with general motor ability r= .086

The following table shows the significance of the r's for the low general motor ability group:

TABLE IV

SIGNIFICANCE OF THE r'S FOR THE LOW MOTOR ABILITY GROUP: df=18

No.	r's	Significant	Insignificant
1.	.31		x
2.	-.38		x
3.	.34		x
4.	-.19		x
5.	.017		x
6.	-.056		x
7.	.095		x
8.	-.051		x
9.	.086		x

For the r's to be significant at the .05 level of confidence, a correlation of .444 is required for eighteen paired observations. All the r's in this group are small and insignificant.

Significance of Difference Between the r's. The correlation coefficients were transformed into Fisher z coefficients in order to find the differences between the correlations of the groups when compared with one another. The r's were transformed into z coefficient by using the table found in Garrett (8:448).

Most of the conversions were not necessary because all r's under .25 are taken as equivalent to Fisher's z coefficient.

Table V shows the difference between the scores in terms of the t statistic. In the tabulation below, the required size of the t ratio is specified for thirty-nine, forty and forty-one degrees of freedom for comparison of high motor ability to low motor ability, middle motor ability to low motor ability and high motor ability to middle motor ability, respectively (9:610).

	# df	Required t at .05 l/c
High vs. Low Motor Ability	39	2.02
Middle vs. Low Motor Ability	40	2.02
Low vs. Middle Motor Ability	41	2.02

Upon analyzing the data presented in Table IV, the investigator found only one t ratio that reached the .05 level of confidence. That t was 2.32 for the significance of difference between correlations of the high and low motor ability groups for right foot outward voluntary rotation.

TABLE V

SIGNIFICANCE OF DIFFERENCES BETWEEN CORRELATIONS FOR HIGH, MIDDLE AND LOW MOTOR ABILITY GROUPS: LAWSON MUSCLE TENSION TEST, LARSON MUSCULAR STRENGTH TEST (GENERAL MOTOR ABILITY) AND SCOTT-FRENCH TEST OF HIP-TRUNK FLEXIBILITY

High	Middle	Low	Diff.	SE_D	df	*t*
Right foot inward voluntary						
-.23	.14		.37	.327	41	1.13
-.23		.32	.55	.336	39	1.63
	.14	.32	.18	.333	40	.54
Right foot inward involuntary						
-.18	.09		.27	.327	41	.08
-.18		.01	.19	.336	39	.56
	.09	.01	.08	.333	40	.24
Right foot outward voluntary						
.38	.003		.377	.327	41	1.15
.38		-.40	.78	.336	39	2.32*
	.003	-.40	.403	.333	40	1.21
Right foot outward involuntary						
.16	.07		.09	.327	41	.27
.16		-.05	.21	.336	39	.62
	.07	-.05	.12	.333	40	.36

*significant at .05 level of confidence

TABLE V (continued)

High	Middle	Low	Diff.	SE_D	df	t
Left foot inward voluntary						
.15	.12		.03	.327	41	.09
.15		.35	.20	.336	39	.59
	.12	.35	.23	.333	40	.69
Left foot inward involuntary						
-.23	.05		.28	.327	41	.85
-.23		.09	.32	.336	39	.95
	.05	.09	.04	.333	40	.12
Left foot outward voluntary						
.08	.22		.14	.327	41	.42
.08		-.05	.13	.336	39	.38
	.22	-.05	.27	.333	40	.81
Left foot outward involuntary						
.09	.15		.06	.327	41	.18
.09		-.19	.28	.336	39	.83
	.15	-.19	.34	.333	40	1.02
Scott-French Test of Hip-Trunk Flexibility						
-.07	-.06		.01	.327	41	.03
-.07		.08	.15	.336	39	.04
	-.06	.08	.14	.333	40	.04

III. SUMMARY

The zero-order correlations between Lawson's test, both voluntary and involuntary, and Larson's test were very small; in all cases but one were not statistically significant. The exception was the correlation of 0.29 for the relationship between left foot outward voluntary rotation and general motor ability, significant at the .05 level of confidence. The zero-order correlation between the Scott-French Bobbing Test and Larson's test was also insignificant (0.015).

A rank-ordered listing of the scores of the sixty-three subjects on the Larson Muscular Strength Test (general motor ability) enabled three motor ability groups to be created. Use of *t* ratio test for significance between means of the group showed that the high, middle and low groups thus created were from statistically-different motor ability populations, as the *t*'s all exceeded the .05 level of confidence. Thus, a rational basis existed for testing the hypothesis that boys exhibiting superior motor ability would possess significantly less muscular tension. A *t* test for the significance of difference between correlations failed to show any difference except one which was significant. The exception was the difference in correlations between high and low motor ability groups for Lawson's right foot outward voluntary rotation versus Larson's Muscular Strength Test (general motor ability).

Chapter V presents brief conclusions and some recommendations for further study.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

I. CONCLUSIONS

From the findings in this study, several conclusions were drawn.

A very slight, positive--but not significant--relationship was found between (1) Lawson's Muscle Tension Test and general motor ability, (2) Lawson's Voluntary Muscle Tension Test and general motor ability; and (3) Scott-French Bobbing Test and general motor ability. Therefore, it was concluded that--because the magnitude of relationship between the Scott-French Test and general motor ability was approximately the same as that of the Lawson Lower Extremity Test of Muscle Tension--the two are apparently similar.

The size of the correlations between Lawson's tests and Larson's test forces one to conclude that for this sample of high school boys utilizing these tests, muscle tension bears no demonstrable relationship to general motor ability.

When the sample of sixty-three boys was partitioned into three separate general motor ability groups--shown to be from statistically different motor ability populations--only the difference between high and low motor ability groups for correlations between right foot outward voluntary rotation was significant at the .05 level of confidence, from among the twenty-four correlation differences computed. Thus, the one-tailed operational hypothesis that boys demonstrating superior general motor ability would possess significantly less muscular tension, must be rejected.

II. RECOMMENDATIONS

It is recommended that a closer look be taken at muscle tension with a different general motor ability test. It is the feeling of this investigator that a test which includes agility testing would be much better at predicting one's tension.

The number of boys taking this test was limited only to sophomore and junior boys at Cle Elum High School. If more boys had been available, the results of this study may have taken a different direction.

It is, therefore, the recommendation of this investigator that further study in this area be conducted with different general motor ability tests and with a greater number of subjects.

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Please note:

Page 42 is missing from this thesis bibliography.

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A P P E N D I X

APPENDIX

ORIGINAL DATA

LARSON TEST

Subject's Score on Test	Chins	Dips	Vertical Jump	Scott-French
100	18	19	22.8	5
100	13	20	24.1	2.5
97	20	14	19.5	2
97	20	20	18.5	4
94	14	20	28.1	6
93	15	13	21.9	2.5
88	13	19	20.7	6
88	12	13	19.4	3.5
85	12	16	17.5	4
84	12	16	20.6	1
84	12	13	20.7	4
82	14	14	24.7	5
81	14	14	18.8	6.5
80	11	11	20.1	7
80	13	17	18.0	1.5
80	14	10	19.1	6
79	10	8	22.0	3
78	13	17	22.9	10
78	13	18	21.8	3.5
76	10	13	20.0	1
76	14	15	17.1	3.5
75	12	12	23.5	3
75	7	12	21.4	3.5
74	11	5	20.8	4
74	10	12	19.2	4
74	13	14	17.2	2
73	13	10	17.9	0
73	15	16	19.8	2
68	11	11	21.6	1
67	5	9	21.1	4
67	11	11	21.2	1
66	12	12	19.8	2
66	8	5	19.6	3
65	11	6	21.5	7
64	9	13	20.8	5.5
64	10	8	21.2	9
64	15	10	17.7	2.5
64	12	8	15.7	3

LARSON TEST (continued)

Subject's Score on Test	Chins	Dips	Vertical Jump	Scott-French
64	11	16	20.5	-1.5
63	9	11	16.9	2
63	8	8	17.8	1
62	5	9	23.5	1
62	6	10	21.6	4
61	11	12	18.6	1.5
59	8	10	16.1	5
57	8	10	19.1	1
57	7	3	21.3	4
57	7	13	19.2	5
57	3	7	15.2	1
56	8	10	18.9	3
55	7	4	20.5	3.5
53	5	11	19.4	6.5
52	6	7	19.1	5
51	6	4	19.4	6.5
50	4	3	17.4	5
49	6	6	18.4	2.5
48	1	2	21.8	1.5
47	6	5	13.4	2
46	3	3	19.5	5.5
46	3	3	19.7	3.5
43	5	5	14.6	1.5
42	3	1	18.5	0
39	1	1	18.6	4

ORIGINAL DATA

LAWSON'S TESTS*

Subject's Score on Larson's Test	Right Foot Voluntary In	Right Foot Voluntary Out	Left Foot Voluntary In	Left Foot Voluntary Out	Right Foot Involuntary In	Right Foot Involuntary Out	Left Foot Involuntary In	Left Foot Involuntary Out
100	11	14	13	11	14	20	15	19
100	12	10	15	11	19	18	22	17
97	18	13	20	8	23	14	22	14
97	12	15	17	17	18	18	22	19
94	9	17	10	17	14	21	14	20
93	15	11	11	10	15	18	15	15
88	13	13	18	13	19	15	21	18
88	17	10	17	12	21	16	22	19
85	15	15	18	14	17	19	21	18
84	17	12	21	11	19	16	21	15
84	13	10	12	5	20	14	20	11
82	8	9	6	13	14	19	12	18
81	9	12	9	13	12	19	13	17
80	14	8	13	10	20	10	17	16
80	16	16	16	14	21	19	19	18
80	16	10	15	7	21	16	22	14
79	19	9	16	11	21	18	21	18
78	14	14	14	9	20	21	19	19
78	15	11	13	10	18	16	20	14
76	16	12	16	16	19	18	18	19
76	13	8	12	13	18	15	18	18
75	12	8	14	12	22	15	20	17
75	12	9	12	8	16	17	17	16

*All measurements specified in units with each unit equalling five degrees.

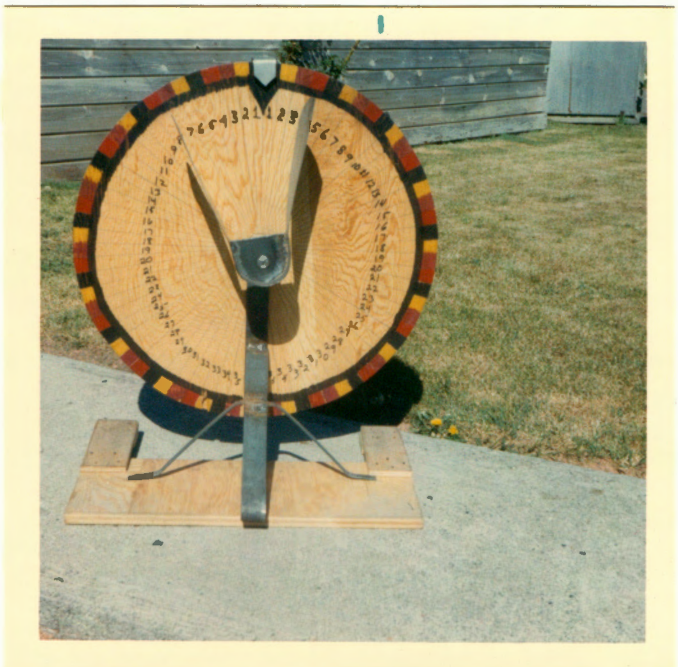
LAWSON'S TESTS (continued)

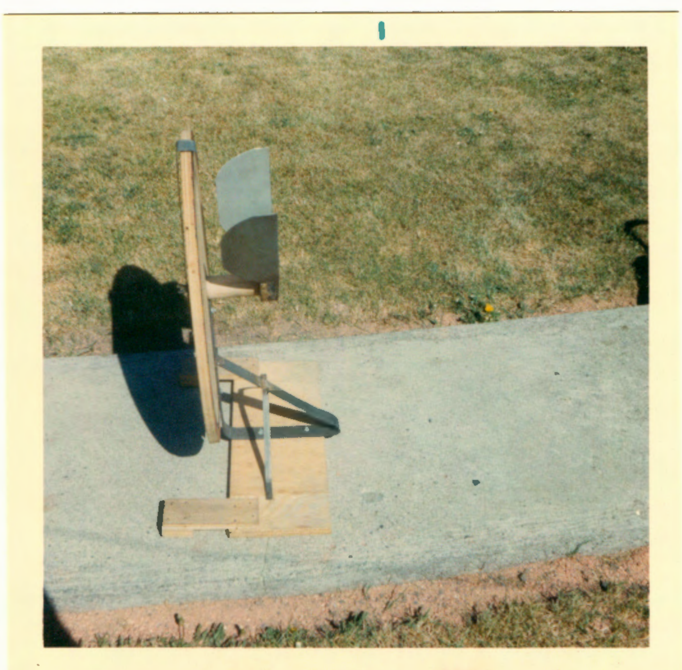
Subject's Score on Larson's Test	Right Foot Voluntary In	Right Foot Voluntary Out	Left Foot Voluntary In	Left Foot Voluntary Out	Right Foot Involuntary In	Right Foot Involuntary Out	Left Foot Involuntary In	Left Foot Involuntary Out
74	26	11	21	10	30	18	25	16
74	10	10	12	12	15	17	16	18
74	16	10	16	11	20	15	18	17
73	12	12	11	16	16	18	16	19
73	11	15	15	14	17	19	19	17
68	14	12	14	15	19	18	21	18
67	7	8	9	8	14	14	14	15
67	15	10	19	8	20	16	24	14
66	13	12	17	8	20	16	21	15
66	12	8	8	6	18	17	14	18
65	20	6	23	5	22	10	25	11
64	11	12	10	13	17	19	17	20
64	13	7	12	8	20	16	17	17
64	14	10	18	8	21	18	23	15
64	18	14	17	14	24	18	23	17
64	7	18	11	15	13	22	14	19
63	14	14	21	13	20	19	23	18
63	13	11	10	13	20	17	19	19
62	11	9	9	8	16	13	15	14
62	12	6	8	7	17	14	13	14
61	12	12	18	10	19	17	21	13
59	19	12	14	17	20	18	18	13
57	16	12	13	12	20	16	16	18
57	8	8	11	6	15	13	14	16
57	13	8	13	14	15	18	15	19
57	17	11	18	9	21	16	24	13
56	15	8	16	12	21	16	17	19
55	12	11	14	10	17	16	19	15
53	12	7	9	8	14	12	15	14
52	6	16	8	12	10	18	12	16

LAWSON'S TESTS (continued)

Subject's Score on Larson's Test	Right Foot Voluntary In	Right Foot Voluntary Out	Left Foot Voluntary In	Left Foot Voluntary Out	Right Foot Involuntary In	Right Foot Involuntary Out	Left Foot Involuntary In	Left Foot Involuntary Out
51	20	6	18	5	26	12	24	12
50	16	12	16	10	20	19	19	17
49	13	9	12	7	18	15	16	15
48	9	11	11	9	13	17	13	18
47	15	14	16	10	22	20	20	18
46	15	14	14	8	19	20	21	15
46	14	11	17	10	19	19	21	16
43	11	11	10	7	19	15	19	15
42	10	14	12	9	15	20	17	14
39	8	14	9	15	14	19	14	19

TESTING MACHINE





INWARD ROTATION

OUTWARD ROTATION