Development of an evaluative test of athletic power for offensive linemen

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The University of Montana
THE DEVELOPMENT OF AN EVALUATIVE TEST OF ATHLETIC POWER
FOR OFFENSIVE LINEMEN

By

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Dean, Graduate School

Date

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T.L.K.
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CHAPTER I

INTRODUCTION

I THE PROBLEM

American football is a game enjoyed by many and participated in by an overwhelming number, from grade school youths up through the men associated with the professional game. At each level of participation coaches must make evaluative decisions. Fuoss (17) advocates that while football may be thought of as a game of strategy and deception, reduced to its basic components it is a game of movement and execution of the fundamental skills. Other things being equal, the proficiency in these fundamental components is the winning edge in athletics (17).

Coaches have long been aware that certain abilities, techniques, and skills must be determined as a basis for evaluating the players and deciding who the best players actually are. Studies by experts in the field over the last thirty years have noted several basic components of performance necessary for success in football. By looking at the various player positions common to American football, certain generalizations concerning the specific components of performance necessary for success can be made.

The tasks of the backfield vary markedly from those of the offensive interior linemen, and these two differ again from those of the wide receivers. With this practical and noticeable differentiation of tasks, it stands to reason then that the components of performance also differ accordingly. That the team with the most powerful line generally achieves the greatest success and therefore wins the football game has long been an
accepted football axiom. In 1938, Bernie Oakes (28) made reference to the importance of power in football by advocating and employing a great deal of practice "to keep the men low and to get the greatest power out of the shortest run."

In 1939, Killinger (24) stated, "In the parlance of the football field it is often said that the game is won up front." Brace (5), Bateman and Governalli (3), and Fuoss (18), in each of the past three decades, have indicated that a team is only as successful as are its linemen, and all three works singled out power as a paramount component of performance when dealing with linemen (3, 5, 18).

A brief review of the scientifically oriented aspects of power as they pertain to human movement and more specifically to athletic movements of short duration, i.e. the offensive line charge, would offer useful background for the subject. Many studies have been devoted to this subject; however, only a brief cross-section of this literature will be presented here so that the basic concepts might be more fully understood.

Dill (13) pointed out that in bursts of all-out exercise, man reaches his maximal rate of energy output within a few seconds and can maintain this rate, depending upon the specific nature of the activity (i.e. sprinting, or blocking against resistance) for twenty or thirty seconds. This description lends itself to an offensive lineman's charge rather appropriately.

Margaria, Aghemo, and Rovelli (27) have suggested that the power output of maximal muscular exertion sustained over a few seconds is
appreciably more than that reached during exercise of long duration and submaximal work loads. They developed a test of this "anaerobic power" in man utilizing a stair-case run as the criterion of evaluation.

Ganong (19) stated that during these short bursts of maximum output the oxygen supplies of man's systems are insufficient, yet the body's muscles continue to contract via anaerobic means. The pyruvic acid formed from glucose does not enter the Kreb's cycle but is instead reduced to lactic acid. The reaction moves as follows:

\[
\text{Glucose} + 2 \text{ ATP} \xrightarrow{\text{anaerobic}} 2 \text{ Lactic Acid} + 4 \text{ ATP}
\]

Ganong continued (19), "The presence of an anaerobic pathway for glucose breakdown has an important physiological consequence. During muscular exercise, the muscle blood vessels dilate and blood flow is increased so that the available \(O_2\) supply is increased. The magnitude of this increase is indicated by the fact that the metabolic rate of muscle during exercise may be 100 times the rate at rest."

When muscular exertion is very great the aerobic synthesis cannot keep pace, and the phosphocreatine resynthesis of ATP is utilized as the replenishing mechanism. The anaerobic breakdown of glucose supplies the energy for this resynthesis; but, despite rapid diffusion of the end product, lactic acid, into the blood stream, a restrictive amount accumulates in the muscle tissues that is in simplest terms just too great for the tissue buffers to neutralize. The total restrictive effect occurs as a result of an enzyme-inhibiting decline in pH. Nevertheless, this anaerobic pathway permits, for a short period, muscular exertion that greatly exceeds any exertion that is possible without it (19). After these periods of anaerobic exertion, an extra amount of
oxygen is consumed to remove the lactic acid build up. This extra oxygen consumed to bring about the resting equilibrium is generally defined as the oxygen debt (6, 7, 19).

It should be noted that measurement of these short bouts of maximal muscular exertion in physical education has recently become controversial enough to warrant the recognition of two types of power measures: (1) athletic power measurement, and (2) work power measurement (23). According to Johnson and Nelson (23), "power may be identified as the ability to release maximum force in the fastest possible time, as is exemplified in the vertical jump, ... the shot put, and other movements against resistance in a minimum of time."

Athletic power is expressed in terms of the distance through which the subject's body or an object is propelled, whereas for work power measurement the result is usually based upon computations of power or \( P = \text{work/time} \) (19). Because of the nature of the offensive line charge in football, where the interior linemen actively propel the opposing team's line, the more appropriate measure would be that of the athletic power measurement.

With the importance of power during short periods of maximal exertion established, it seems appropriate to relate physical attributes that are common to good linemen. They were as follows: 1. powerful plantar flexion of the ankle and extension of the knee and hip, 2. quick powerful thrust, 3. proper arm and shoulder attacking ability, 4. maintenance of power via follow-through of the movements, 5. coordination as well as balance.
Ford (16) devoted an entire thesis to a descriptive analysis of offensive linemen rated as outstanding in the execution of the shoulder block. Selected physical traits of these outstanding linemen were presented as follows: 1. outstanding leg strength, 2. good movement time, 3. great amount of force upon impact, 4. maintenance of force after impact. The implications for power in the shoulder block are clearly evident.

With all of the apparent emphasis upon the power of football linemen, it would seem likely that coaches would have a quantitative means of evaluating player power. This has not been the case. Rather, the coach designated to evaluate the linemen as to their abilities relies upon his experience in previous situations comparable in nature, his daily observations, possibly upon something as superficial as the personality of the boys involved, and sometimes upon an educated hunch.

Are these subjective means valid measures of one's actual power potential? Does the athlete have any idea of the means used to evaluate him? Does he have any objective measure of his actual power to strive against as a means of improving himself? How accurately are coaches able to determine their own ball player's ability with regard to power output? These are a few of the questions that need to be investigated with regard to American football in the 1970's. A likely solution to many of these questions would be to develop a test to determine the power of athletic performers, specifically football offensive linemen, and attempt to evaluate the linemen on the basis of the test results.
Statement of the Problem

The purpose of this study was to develop an evaluative test of athletic or anaerobic power for college football linemen. More specifically the problem investigated was to determine whether a football power technique involving a charge against the resistance of a football sled could be utilized as a valid and reliable means of evaluating linemen.

Significance of the Study

The information in the related literature which pertained to athletic or anaerobic power did in no way deal with the power component as an evaluative measure for classification of football linemen. The literature over the past four decades recognized the importance of power, but no tests have been utilized to measure it specifically. By way of the following items it was felt that this study would aid in the establishment of these means:

1. Football technique, common to all football programs was used as the test.
2. Football players concerned with this type of work may be interested in the results as a classification index of their ability with regard to power.
3. Football players may use the index of classification as a reference point for improvement and as such be motivated to improve.
4. The test is a measure of a meaningful, physically well defined characteristic of good football linemen, namely, power output.
5. Coaches might utilize this test as an objective ranking of power for their linemen.

Scope of the Study

This study was concerned with only the following aspects of the overall problem:

1. Only one specific measure of football ability, power, was evaluated.

2. The interior offensive line, centers, guards, tackles, and tight ends were measured.

3. Only those members of the University of Montana Football Team during their spring practice, 1970, were measured.

4. Only one type of blocking machine was used.

Definitions of Terms

The meanings of certain terms vary when used in football. Many times there is a variance in meaning among players on the same team. To make the terms that were involved in this study more easily understood the following terms were defined:

Components of Performance - Components of performance are those abilities, either hereditary or developed, which are necessary for success in American football.

Football Stance - Football stance is the position a football player assumes at the beginning of each football play. The stance used by the offensive interior linemen at the University of Montana and in this study was the four point stance.
**Offensive Charge** - Offensive charge is the ability of the offensive lineman, upon the snap of the ball, to attack the defensive player representing a resistive force and to move him sufficiently so as to provide a pathway for the ball carrier. This act requires the offensive lineman to possess the ability to generate and maintain an amount of power that is greater than that of the defensive player.

**Power** - Power is the ability to release maximum force in the fastest possible time against a resistance. By formula: \[ \text{Power} = \frac{\text{force} \times \text{distance}}{\text{time}} \]

The measure in this study will be made in foot-pounds. Force is defined as mass x acceleration.

**Football (the game)** - American football when used in this study, concerns itself with the game of tackle football as it is played at the intercollegiate level of competition.

**II RELATED STUDIES**

Although a sizeable amount of work has been done in the areas of testing general athletic potential and potential in specific athletic abilities, the field of testing football potential utilizing power as the specific component of performance measured has been neglected. Nevertheless, studies have been done which utilized phases of football performance as criteria of evaluation in predicting football potential of linemen.

Cormack (10) developed two tests to determine this potential. A formula was developed that used the McCloy General-motor-capacity Score plus the McCloy Dipping-strength Score. The R of .718 was calculated when coaches' ratings were correlated with the results of the test. His
second test utilized the McCloy Classification Index minus the forty
yard dash score plus the twelve pound shot put score plus the McCloy
Dipping-strength Score. This second test correlated at .831 with
coaches' rankings. Although sizeable correlations were found, this
test failed to use any measure related to the offensive charge in
football.

Hatley (21) incorporated the Cozens Dodging run, the McCloy
General-motor-capacity Score, and the twelve pound shot put score into
a formula which resulted in an $R = .68$ when correlated with the ratings
of four judges. Again, only general ability of linemen was the concern
of the study.

Brace (5) made a study of the validity of football tests as the
basis for the selection of players. The tests included were very specific
to the various positions of the football team. Three of these factors
out of the eight test factors that were analyzed had to do with the
selection of linemen. Of these three, one had to do with the offen­
sive charge where a harness was attached to a back and leg dynamometer.
This test was designed as a measure of work, directly associated with
power with the implementation of a time factor, and was found to be
useful in predicting potential linemen.

More recently Edwards (15) made a study to determine a method for
selecting linemen for high school football. His study concluded that
more importance should be stressed in the area of testing gross motor
skills when dealing with football players for the line rather than the
more refined traits, i.e. hand-eye coordination, peripheral vision, and
reaction time.
In 1960, Lee (25) devised a battery of tests to predict football potential in junior college football players. Only the bench press test had a significant correlation for prediction when compared with the predictions of a jury of experts. The items included in the battery were: height-weight, bench press, pull-ups, bar dips, 50 yard dash, 100 yard dash, leg press, and obstacle run. The entire forty-four member squad at Arizona Western College was tested, and no attempt was made to predict for specific positions, i.e. offensive backs, offensive linemen, ends, etc.

In conclusion, it was found that very little research and related literature was available regarding the power component in American football regardless of the importance placed upon it throughout the last four decades.
CHAPTER II

PROCEDURE

The method of this study was analytical and evaluative. The University of Montana Football Coaching Staff, acting as a jury of experts, analyzed the power of the players who were used as subjects in the study and ranked them from the most powerful subject through the least powerful subject. A numerical ranking from these subjective evaluations was utilized with the most powerful subject receiving a ranking of "1" (Appendix A). The coaching staff used only their past experiences with the ball players as the means of ranking the subjects, and the coaches' rankings were collected before the subjects were tested.

I. THE SUBJECTS

The actual offensive line positions from which the subjects for this study were taken included tight end, offensive tackle, guard and center. The split-end position, although technically a member of the offensive line, was not included in the study because the primary duty of this position is to receive forward passes and is therefore isolated from the offensive interior linemen mentioned above.

The selection of the subjects was on a compulsory basis with the members of the 1970 University of Montana Spring Football team selected. Only the football players who were placed at the offensive interior line positions were utilized as subjects. They were specifically positioned
as a result of their past football experiences and assigned these positions through an agreement between the player and the coaches. It may be noted that by virtue of participation in intercollegiate football competition, these linemen were designated as outstanding.

The sixteen subjects exhibited a wide range of differentiating physical traits as can be seen in Table 1.

Table 1.
Physical Traits of the Subjects

<table>
<thead>
<tr>
<th>Subjects (last name)</th>
<th>Height (feet-inches)</th>
<th>Weight (pounds)</th>
<th>40 yard dash (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darrow</td>
<td>6'5&quot;</td>
<td>240</td>
<td>5.4</td>
</tr>
<tr>
<td>Stachnik</td>
<td>6'1&quot;</td>
<td>235</td>
<td>5.4</td>
</tr>
<tr>
<td>Semple</td>
<td>6'2&quot;</td>
<td>220</td>
<td>5.1</td>
</tr>
<tr>
<td>DeBord</td>
<td>6'2&quot;</td>
<td>200</td>
<td>4.9</td>
</tr>
<tr>
<td>Bodwell</td>
<td>6'4&quot;</td>
<td>210</td>
<td>5.0</td>
</tr>
<tr>
<td>Hare</td>
<td>5'11&quot;</td>
<td>190</td>
<td>5.5</td>
</tr>
<tr>
<td>Postler</td>
<td>6'5&quot;</td>
<td>230</td>
<td>5.2</td>
</tr>
<tr>
<td>Lyster</td>
<td>6'0&quot;</td>
<td>225</td>
<td>5.6</td>
</tr>
<tr>
<td>Okoniewski</td>
<td>6'3&quot;</td>
<td>235</td>
<td>5.1</td>
</tr>
<tr>
<td>Hovdey</td>
<td>6'2&quot;</td>
<td>205</td>
<td>5.0</td>
</tr>
<tr>
<td>Dorland</td>
<td>6'2&quot;</td>
<td>230</td>
<td>5.7</td>
</tr>
<tr>
<td>Lugviel</td>
<td>6'3&quot;</td>
<td>240</td>
<td>5.5</td>
</tr>
<tr>
<td>Johnson</td>
<td>6'0&quot;</td>
<td>215</td>
<td>4.9</td>
</tr>
<tr>
<td>Angelo</td>
<td>6'1&quot;</td>
<td>190</td>
<td>5.0</td>
</tr>
<tr>
<td>Leid</td>
<td>6'2&quot;</td>
<td>225</td>
<td>5.3</td>
</tr>
<tr>
<td>Elvert</td>
<td>6'1&quot;</td>
<td>225</td>
<td>5.3</td>
</tr>
</tbody>
</table>

Means                  | 6'2"                 | 220             | 5.2                    |

The subjects were oriented to the purpose of the study, the testing procedures which they would follow, and the importance of a maximal exertion while being tested (Appendix B). The amount of practice that
was obtained as a result of prior football drills was useful for introducing the subjects to the testing apparatus. All of the subjects had prior training with the Gilman Sled.

II. EQUIPMENT

Personal Football Equipment

The subjects were controlled as to the equipment that was worn during testing. It included: a padded suspension helmet, chin strap, shoulder pads, t-shirt, practice jersey, athletic supporter, hip pads, thigh pads, knee pads, football pants, belt, two pair of socks, and low-cut football shoes with hardened rubber cleats. (These materials are considered as a standard and essential football outfit and are worn by all members of the University of Montana Football Team.)

Football Sled

The blocking apparatus that was selected for this study was the Gilman Chargeback - Tackleback - Driveback, Football Sled. It was selected because it is designed for use by one man at a time, common to all of the subjects, and moves along a straight pathway when hit by a lineman. This allowed for ease in measuring the displacement of the sled.

Stop Watches

A Minerva stop watch with a ten second sweep motion was used for timing the test periods. The rest periods were timed by a second, identical watch.
Data Sheet

A data sheet was developed for use with the Grizzly Football Power Test (Appendix C).

Automatic Timing Device

The times recorded for Margaria's Stair-Case Run were taken from the Automatic Performance Analyzer Model 631. The device is calibrated and accurate to time in 1/100ths of a second. This analyzer provided precise timing without the common faults of human error. The accessories that were used for the Margaria Stair-Case Run included: the line control, the switch mat, and the start switch. All accessories used are further described in the instruction booklet accompanying the analyzer.

Tomac Goniometer

This instrument was used during the leg strength test to secure the proper angle of knee flexion. A 110 degree angle was established by finding the correct marking on the moveable protractor, and fitting the subject's knee flexion angle to the angle of the goniometer. With the establishment of the correct angle, the lift was started.

Dynamometer

A dynamometer was utilized during the study to measure leg strength and to measure the force needed to overcome the resistance of the Gilman Sled. It was calibrated in tens of pounds and ranged from 0 lbs. to 2500 lbs. An accuracy check for the lower measures on the dynamometer was made and the following calibration corrections were found:
dynamometer recording  |  actual measure  
---------------------|---------------------
(lbs.)               | (lbs.)               
50                   | 100                  
70                   | 120                  
90                   | 140                  
110                  | 155                  
130                  | 170                  

Miscellaneous Materials

Other materials were used during the testing procedure. Because of their widespread and common use it was not felt a discussion describing these materials was needed. They included:

1. one 100 foot measuring tape
2. five marking pins
3. two pencils
4. one whistle
5. one clipboard

III TESTING PROCEDURES

The testing of subjects was conducted in conjunction with spring football practice during Spring Quarter at the University of Montana. Three tests were administered to the subjects. (A new test, the Grizzly Football Power Test, a modified Margaria's Stair-Case Run Test, and a leg strength test were the three tests performed by various subjects.)

Grizzly Football Power Test

For the administration of the Grizzly Football Power Test (GFPT) only two individuals were utilized, the marker-timer, and the recorder.
1. The marker-timer was concerned with marking the displacement of the sled after the test performance and with the timing of the test and rest periods. He was responsible for announcing the times of the subjects as they finished each test period. He also introduced the testing procedures to all the subjects.

2. The major responsibility of the recorder was to write down the data concerning the subject's leg strength, subject's stair-case run, time of subject's GPPT, and the displacement of the sled during the GPPT. He also assisted in measuring the sled's displacement.

**Warm-up**

The warm-up procedures were regulated for every subject. A combined isotonic and isometric regimen of warm-up exercises was completed in unison by all the subjects and consisted of the following:

- 15 side straddle hops (4 count)
- 10 hamstring stretchers (4 count)
- 15 push-ups
- 30 seconds of running in place
- Isometric neck exercises (4 positions, 8 count)
- Isometric leg exercises (2 positions, 8 count)
- 1 three second burst vs. the Gilman Sled

**The Testing Area**

A diagram of the testing area appears in Appendix D. It should be noted that all testing was done on dry grass.
Procedure

The University of Montana Football Coaching Staff, acting as a jury of experts, indicated that if an offensive lineman could maintain his charge for three seconds, the resultant block would be classified as ideal. This three second charge was therefore utilized as the basic time unit assigned for each test period. A multiple test period effort of four offensive charges against the Gilman Sled was utilized. The number of test periods was arbitrarily selected as four. It may be noted, however, that in American football, the offensive team has four downs with which to achieve a first down.

A rest period of twenty seconds between the test periods was chosen. Although this was an arbitrary selection, the time is comparable in length to the time that is spent in the football huddle between plays. The rest period was begun at the conclusion of each test period and alternated with test periods until the conclusion of the fourth and final test period.

Each test and rest period was begun when the marker-timer sounded a whistle. Prior to each whistle designating the start of each test period, the commands, "set" and "ready" were given by the marker-timer in such a manner that the subjects could maintain their four point football stance. These commands are identical with those used by the University of Montana Football Team.

Margaria's Stair-Case Run

Ten of the sixteen subjects who performed the Grizzly Football Power Test were also tested on Margaria's Stair-Case Run. As suggested by
Margaria, Aghemo, and Rovelli (27)), this test was used to measure anaerobic muscular power. The subjects were told to run up a flight of stairs at top speed, two seven inch steps at a time. The measurement for the run was taken over an even number of jumps, two in this case, so that the subject would complete the run on the same foot and in the same phase of movement as he started. Margaria suggested that the time of the tests was to last about 0.40 - 0.50 seconds. (These results were comparable with the results obtained in this study.)

Each subject was given three runs. The first run was used as a practice trial and the second and third runs were averaged for the test score.

The Automatic Performance Analyzer was used as the timing device, and it was started when the subject stepped on the line cord on the first step and stopped when the subject stepped on the switch mat on his third step. The subjects elevated their body weight through a vertical displacement of twenty-eight inches.

**Leg Strength Test**

This test of leg strength was based upon the original leg lift test of Roger's (29). A lifting belt which was three inches wide, 60 inches long, and one-fifth inch thick was placed around the subject's lower hips and gluteal muscles. This belt was held in place by means of attachment to a twenty inch lifting bar. The subject held the bar with both hands near its center and in junction with the thighs and trunk. At the start, the subject's knees were slightly flexed at 110 degree angles and the maximum lift, as recorded by the dynamometer, occurred when leg extension
was nearly complete. The ten subjects who were assigned to Margaria's Stair-Case Run also performed this leg strength test. Two test periods were utilized with the mean score, to the nearest pound, being recorded. According to Rogers (29), this test item has a .86 coefficient of reliability.

IV. TREATMENT OF DATA

The GPFT scores were ranked and related to the coaches' rankings with the Spearman rank-order correlation technique, as described by Downie and Heath (14). In addition, the scores of the ten subjects who performed the leg strength test and Margaria's Stair-Case Run were ranked and related to their rankings on the GPFT with the Spearman rank-order correlation technique. The following physical variables were also related to the Grizzly Football Power Test: height, weight, and 40 yard dash. Correlation coefficients among all tests utilized in this study were calculated.
CHAPTER III

ANALYSIS AND DISCUSSION OF DATA

The following chapter presents the analysis of the data obtained from the Grizzly Football Power Test to test its value as an athletic and anaerobic power test. Among variables that were included in the comparison were the following: height, weight, forty-yard dash speed, Margaria's Stair-Case Run, leg strength, and coaches' rankings.

I. ANALYSIS OF RESULTS

Reliability of GFPT

Two trials of the GFPT were administered on successive days. A highly significant reliability coefficient of 0.84 was found between $T_1$ and $T_2$. The mean difference was highly significant ($t=3.233$). It was theorized that the improvement from $T_1$ to $T_2$ was due to greater familiarity with the testing procedure and equipment. These data suggest that several trials are necessary to achieve a stable GFPT score.
<table>
<thead>
<tr>
<th>Subjects</th>
<th>GFPT (ft.-lb)</th>
<th>Expert Rankings</th>
<th>Stair Run (ft.-lb.)</th>
<th>Leg Strength (pounds)</th>
<th>40 yard dash (sec.)</th>
<th>Weight (pounds)</th>
<th>Height (ft.-ins.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postler</td>
<td>974</td>
<td>2</td>
<td>1448</td>
<td>1505</td>
<td>5.2</td>
<td>230</td>
<td>6'5&quot;</td>
</tr>
<tr>
<td>Okoniewski</td>
<td>945</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>235</td>
<td>6'3&quot;</td>
</tr>
<tr>
<td>Johnson</td>
<td>939</td>
<td>4</td>
<td>1252</td>
<td>1155</td>
<td>4.9</td>
<td>215</td>
<td>6'10&quot;</td>
</tr>
<tr>
<td>DeBord</td>
<td>897</td>
<td>8.5</td>
<td>1024</td>
<td>1075</td>
<td>4.9</td>
<td>200</td>
<td>6'2&quot;</td>
</tr>
<tr>
<td>Bodwell</td>
<td>893</td>
<td>6</td>
<td>1179</td>
<td>1250</td>
<td>5.0</td>
<td>210</td>
<td>6'4&quot;</td>
</tr>
<tr>
<td>Leid</td>
<td>871</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td>3.3</td>
<td>225</td>
</tr>
<tr>
<td>Darrow</td>
<td>842</td>
<td>7</td>
<td>1330</td>
<td>1248</td>
<td>5.4</td>
<td>240</td>
<td>6'5&quot;</td>
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<tr>
<td>Semple</td>
<td>838</td>
<td>12</td>
<td></td>
<td></td>
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<td>205</td>
<td>6'2&quot;</td>
</tr>
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<td>Hovdey</td>
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<td>895</td>
<td>5.1</td>
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<td>6'2&quot;</td>
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<tr>
<td>Lugviel</td>
<td>807</td>
<td>5</td>
<td></td>
<td></td>
<td>5.5</td>
<td>240</td>
<td>6'3&quot;</td>
</tr>
<tr>
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<td>11</td>
<td>995</td>
<td>805</td>
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<td>190</td>
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<td>1030</td>
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<td>Lyster</td>
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<td>15</td>
<td>1028</td>
<td>850</td>
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<td>16</td>
<td>1152</td>
<td>795</td>
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<td>Elvert</td>
<td>687</td>
<td>13</td>
<td></td>
<td></td>
<td>5.3</td>
<td>225</td>
<td>6'1&quot;</td>
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</table>
Comparison of Tests in the Study

In Table III, correlation coefficients among all tests performed in this study are listed with their significance, where existent, designated by subscripts.

Table III
Correlation Coefficients Among Tests Administered in the Study

<table>
<thead>
<tr>
<th>Test Item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<tbody>
<tr>
<td>1. Weight</td>
<td>.63&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-.46</td>
<td>.67&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.29</td>
<td>.31</td>
<td>.08</td>
<td></td>
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<tr>
<td>2. Height</td>
<td>.04</td>
<td>.72&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.67&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.63&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.51</td>
<td></td>
<td></td>
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<tr>
<td>3. 40 Yard Dash</td>
<td>.17</td>
<td>.53</td>
<td>.39</td>
<td>.60&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Stair-Case Run</td>
<td></td>
<td>.74&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.70&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.55&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>5. Leg Strength</td>
<td></td>
<td>.93&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.84&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
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<td>6. Expert's Rankings</td>
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<td>.69&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>7. GFPT</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

<sup>a</sup> Significant beyond the .05 level of confidence
<sup>b</sup> Significant beyond the .01 level of confidence

The GFPT and Expert Opinion

In order for a test to be applicable to any athletic activity it would seem plausible that the test would compare favorable with expert opinion concerning the same variable. For this reason a jury of experts, consisting of the University of Montana Football Coaching Staff, was
employed to rate the sixteen subjects involved according to each subject's power. These results, when related with the results of the GPPT yielded the relationship depicted in Tables II and III.

All power calculations for this study were done by the methods outlined in Appendix E. The rankings were made independent of the power calculations.

Because the rho of .69 was significant at the .05 level of confidence, it would appear the GPPT is related to football power. The significant correlation with the ratings of experts may also suggest that the coaches are able to rate the player's ability to produce power relatively accurately. Evaluation of personnel is certainly a very important task for all coaches to perform.

The GPPT and Margaria's Stair-Case Run

By comparing the GPPT with a recognized test of anaerobic power, some relationships of athletic power with anaerobic power might be established. Since coaches in athletics often stress the power aspect of an activity, they may be stressing the importance of anaerobic power in the athletic activities without being specifically cognizant of the fact. The significant correlation (Table III) exemplifies the relationship of athletic power, as measured by the GPPT, to anaerobic power, as measured by Margaria's Stair-Case Run. From this data, it would appear that anaerobic and athletic power share similar traits.
Because of the importance of leg movement to the offensive line charge, it was theorized that leg strength would be related to power and the GPPT. In running a Spearman rank-order correlation for the GPPT and a leg strength test (Table III,) a highly significant rho of .84 was found. This indicated that individuals possessing high leg strength achieved high scores on the GPPT.

The relationship of speed to power is obvious in the formula:

\[
\text{Power} = \frac{\text{force} \times \text{distance}}{\text{time}} = \text{mass} \times \text{acceleration}.
\]

It would therefore seem feasible that those subjects who were faster would be able to achieve a higher ranking on the GPPT.

These results (Table III) show the strength of the relationship between running speed and the GPPT. Coaches are constantly evaluating all of their players in regard to speed. These results indicate that this exercise may offer a valuable means of evaluating personnel for tasks in which power is involved.

Much emphasis in football is placed upon the weight of the players involved. When relating the individual weights of the subjects with their results on the GPPT, an interesting correlation (rho = .08) was found. This may be due to the fact that the mean weight of the subjects
could be considered rather high at 220 pounds. Also the range of the weights of subjects tested was 50 pounds with 88 percent of the subjects over 200 pounds. This factor could have easily influenced the relationship.

The height of the college football players used as subjects ranged from 5'11" to 6'5". With such a range of height it was theorized that the taller the subject was, the better his performance on the GPFT would be. When testing to see if this relationship was evident, a non-significant rho of .51 was found.

II. DISCUSSION

Costill (11) studied the relationships of leg strength tests and power in football players. Before any comparison can be made between Costill's study and this one, certain differences in the samples of the studies should be pointed out. Costill's sample size was 76 and was made up of players from all positions on the football team while but 16 offensive interior linemen were tested in this study. Differences in ranges of scores existed because Costill tested the smallest, largest, fastest, and slowest members of the entire football team while the interior linemen playing offense composed the entire sample of this study.

Costill concluded (11) that anaerobic power was significantly related to dynamic leg strength. It was suggested that because individual body weight was utilized in calculating anaerobic power, it was a leading factor in obtaining significance between anaerobic power and dynamic leg strength.
Dynamic leg strength as measured in this study (Table II) had numerous significant relationships with the other test items. A significant correlation of .74 was found when relating leg strength and anaerobic power (Table III). In addition, other significant relationships were found between leg strength and height (.67), expert's rankings (.70), and the GFPT (.55) as pointed out previously.

In comparing weight and anaerobic power, a significant rho of .67 was found (Table III). This compared favorable with the results obtained by Costill (11) where the correlation coefficient was .848.

Weight and height correlated with a significant .63 coefficient in this study (Table III). This may be interpreted to say that for these subjects, the taller they were the more they generally weighed.

In relating height and weight to leg strength (Table III), correlations of .67 and .29 respectively were found. These results were opposite of what Costill found (11). The differences may be explained in part by the differences in samples and their ranges, as pointed out earlier.

One other relationship was evident between Costill's results (11) and the results of this study. In both cases, speed, as measured by the 40 yard dash, had very little relationship with anaerobic power (.117 and .17 respectively). It was expected that linear speed would have significant relationships with many of the other tests; however, in no instance in this study was a significant relationship found, other than the .50 relationship with the GFPT.
Coaches' and Players' Feelings About the GFPT

Although no formal analysis was attempted to evaluate the coaches' and players' feelings toward the GFPT, certain observations were made during the testing.

1. At least one coach was present during most testing sessions.
2. Great competition was displayed by the players involved.
3. The GFPT physically taxed the players as was evident by their heavy breathing and display of perspiration upon completion of the test.
4. Great interest was exemplified by the players in their final results and rankings.
CHAPTER IV.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

This study was conducted to develop an evaluative test of athletic power for football offensive linemen. Sixteen offensive linemen, players on the University of Montana's varsity football team during Spring Quarter, 1970, were selected as subjects and were evaluated according to their success on certain tests.

Each subject was given a new test, the Grizzly Football Power Test, to obtain an athletic power ranking. For each subject two similar test periods were attempted, the score in ft.-lbs./sec. obtained, and these scores averaged to compute the mean score. This mean score served as the basis for ranking the subjects.

Concurrently with this testing, the subjects were tested on Margaria's Stair-Case Run. This is a recognized test of anaerobic power. The results of this test for ten of the subjects were calculated and a ranking of subjects was employed. A significant Spearman rank-order correlation (rho) of .55 was obtained between the GPPT and Margaria's anaerobic test.

Next, a leg strength test was administered to the ten subjects and after their results were calculated and ranked, the Spearman rank-order technique was employed and a highly significant rho of .84 was found.

The University of Montana Coaching Staff, acting as a jury of experts ranked the sixteen subjects with regard to how powerful they
felt the subjects were. A rho of .69 significant beyond the .05 level of confidence was found when compared with the GFPT.

To note the relationship of speed with the GFPT, each subject's 40 yard dash time was obtained and ranked from the fastest as #1, through the slowest at #16. When related to GFPT results a rho of .60 was obtained, which showed significance at the .05 level of confidence.

Because of the apparent concern of coaches to recruit the larger athletes as linemen, correlations were run to compare height and weight of each of the subjects with the GFPT. In both cases, the relationship proved to be non-significant.

II. CONCLUSIONS

On the basis of the results obtained in the study, the following conclusions were made:

1. For the particular subjects involved in this study, the Grizzly Football Power Test (GFPT) was accepted as an adequate test of athletic power via its significant relationship with a jury of expert's rankings.

2. For this new GFPT, anaerobic power and athletic power were very closely related.

3. Individual leg strength had a highly significant relationship with the GFPT results.

4. The coaching staff's rankings were significantly related to the actual results of the GFPT.

5. The faster the subjects were, the more powerful they generally were with regards to the GFPT.
6. There was no meaningful relationship between individual height or weight and their ability to produce power on the GPPT.

7. The GPPT showed a reliability coefficient of .84.

8. The leg strength tests served as tests of athletic or anaerobic power for these subjects.

III. RECOMMENDATIONS

In view of the findings and conclusions of this study, the following recommendations have been made:

1. For the purpose of ease in measuring the GPPT, an attempt should be made to modify the scoring by selecting a standard distance for subjects to achieve, leaving only the time as the factor that varies.

2. It might be beneficial to adapt the test so that all members of a football team could use it as an evaluative measure of athletic or anaerobic power.

3. In future use of the test it would be beneficial to pre-test before the football season, test during the season, and post-test after the season to measure any changes in individuals which may occur.

4. In light of the relationship of athletic power to anaerobic power, a new realm of coaching, training for anaerobic power in athletics, might be implemented and new dimensions along these lines be developed.
5. More work should be done concerning dynamic leg strength as a possible quick evaluation for coaches trying to estimate their players with regard to anaerobic or athletic power.
BIBLIOGRAPHY


APPENDICES
APPENDIX A

COACHES' RANKINGS OF SUBJECTS' FOOTBALL POWER

TO: ALL UNIVERSITY OF MONTANA VARSITY FOOTBALL COACHES
FROM: TOM KELLER
RE: COACHES' RANKINGS

The study I am conducting involves the development of an evaluative test of athletic power for offensive linemen. Would you please rank the following offensive linemen as to their ability to produce football power. Your rankings will be correlated with the rankings resulting from a new test, the Grizzly Football Power Test.

\[
\text{Power} = \frac{\text{Force} \times \text{distance}}{\text{time}}
\]

RANK NUMERICALLY FROM BEST = #1 THROUGH WORST = # 16

<table>
<thead>
<tr>
<th>Name</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>DePord</td>
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</tr>
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<td>Bodwell</td>
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<td>Johnson</td>
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<td>Borland</td>
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</table>
APPENDIX B

SUBJECT ORIENTATION AND INSTRUCTIONS

TO: OFFENSIVE LINEMEN, SPRING 1970
FROM: COACH KELLER
RE: FOOTBALL POWER TESTING

The data compiled from this testing will be used to supplement research for a professional paper at the University of Montana. The results will be correlated with the coaching staff’s ratings as to how well they feel you will perform on this test in regards to power. Two days are required for this testing. Report on the field at 2:45 Wednesday, May 27, and Thursday, May 28, dressed for contact.

The test will consist of three short parts:

1. Leg Strength Test
2. Stair-Case Run
3. Grizzly Football Power Test

More specific instructions will be assigned at 2:45 on the field.

THANK YOU
COACH KELLER
APPENDIX C

DATA SHEET

NAME:

HEIGHT:

WEIGHT:

40 YARD DASH:

LEG STRENGTH: 1st_______lbs.; 2nd_______lbs.

STAIR-CASE RUN: 1st_______sec.; 2nd_______sec.

GRIZZLY POWER TEST: 1st / sec.; 2nd / sec.
APPENDIX D

DIAGRAM OF TESTING AREA

40 yds. (chalk line)
Margaria's Stair-Case Run

Power = \frac{\text{force} \times \text{distance}}{\text{time}}

where:
- \text{force} = \text{body mass (varies)}
- \text{distance} = 28'' \text{ or } 2.33 \text{ ft.}
- \text{time} = \text{elapsed time of movement (varies)}

example:
\[
\frac{235 \text{ lbs.} \times 2.33 \text{ ft.}}{.41 \text{ sec.}} = 1335 \text{ ft. lbs.}
\]

GFPT

Power = \frac{\text{force} \times \text{distance}}{\text{time}}

where:
- \text{force} = \text{that which was needed to overcome resistance of Gilman Sled (120 lbs.)}
- \text{distance} = \text{varies - how far sled is pushed}
- \text{time} = \text{varies but approximately 12 seconds}

example:
\[
\frac{120 \text{ lbs.} \times 99.5 \text{ ft.}}{12.1 \text{ sec.}} = 997 \text{ ft. lbs.}
\]
APPENDIX F

STATISTICAL PROCEDURES

Spearman rank-order correlation

\[ \rho = 1 - \frac{6 \sum \Delta^2}{N(N^2 - 1)} \]

Significance

\[ t = \frac{\rho}{\sqrt{1-(\rho)^2}} \sqrt{N-2} \]

Pearson product moment correlation

\[ r = \frac{\sum XY - (\sum X)(\sum Y)}{\sqrt{\sum X^2 - (\sum X)^2} \sqrt{\sum Y^2 - (\sum Y)^2}} \]

Significance

\[ \sqrt{S_{x_1}^2 + S_{x_2}^2} = 2 r (S_{r_1})(S_{r_2}) \]