Prediction of Football-playing Ability in Spring Training Tryouts Through the Use of Psychobiomotor Assessment

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PREDICTION OF FOOTBALL-PLAYING ABILITY
IN SPRING TRAINING TRYOUTS THROUGH
THE USE OF PSYCHOBIOLOGICAL ASSESSMENT

BY

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THESIS

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ABSTRACT

Psychobiomotor assessment refers to the use of a combination of psychological, biological, and motor-performance tests to comprehensively analyze the skills, attributes, and performance capabilities of athletes. The purpose of this study was to test the hypothesis that there are significant psychobiomotor differences between successful collegiate football players in the offensive backfield positions and those players who are rated as less successful in these positions. Subjects were 19 male volunteer tryouts (mean age = 20.5) for the positions of quarterback and halfback on the inaugural University of Central Florida football team. They were assessed on the physiological variable anaerobic capacity, the psychological dimensions measured by the Cattell 16PF, and also on four football-playing skills. Football-playing ability (the dependent variable) was assessed by coaches' ratings on 15 sub-variables determined to be important to the offensive backfield positions.

Stepwise multiple linear regression analysis, utilized to give the best linear composite of the predictor variables to the dependent variable, resulted in a multiple correlation coefficient of .82 (p < .005). The
prediction equation included four variables: conservatism, aggressiveness, anaerobic capacity, and pass-receiving ability. Thus, a significant 68% of the variance of football-playing ability was accounted for by the use of these four psychobiomotor variables.

By using a validated test battery, team personnel, performance, profits, prestige, and effectiveness could be improved. Also, a battery could be used to train current team members on areas of relative skill deficiencies.
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Sports in America, and throughout the world, have grown into a multi-billion dollar enterprise. In his book, *Sports in America*, Michener (1980) estimates that in the United States alone over 100 billion dollars a year is spent on sports and recreation. In particular, team sports spend tremendous amounts of money (professional football and baseball teams spend about nine million dollars each year) in an attempt to build solid, successful teams that bring prestige and/or wealth to their owners, members, or sponsors. In order to achieve success, these teams spend great amounts of time and effort to recruit new talent with which to improve their teams. Most organized team sports have a preliminary period, prior to the regular season, during which the coaches work with many new players, hoping to find some who will be considered good enough to be selected to join the team. Typically, however, the team turns away many more recruits than are accepted. A glance at the training camps of the collegiate and professional football and baseball teams bears out this contention. The accurate selection of the proper recruits is obviously an important determinant of a team's performance in competition. Most frequently, selection of players is done by a subjective evaluation
of the candidate's performance prior to and/or during these pre-season training sessions. Recently, however, a trend towards more objective assessment has gained momentum (Pargman, Deshaies, & Boutwell, Note 1).

Over the past thirty years there has been extensive research undertaken to determine the psychological, biological, and motorskill (psychobiomotor) differences between "good" and "poor" athletes. Unfortunately there has been little agreement in the literature on the definition of a good or "successful" athlete. Some studies have compared athletes with non-athletes, such as Fletcher and Dowell (1971) and Slusher (1964), who compared high-school athletes with a normative group of high-school non-athletes on various psychological variables. Werner and Gottheil (1966) compared collegiate athletes to a control group of college non-athletes on psychological measures.

Other studies have defined success as a difference in level of competition. For example, Carlson (1969) compared college athletes who competed in intercollegiate games with those athletes who had never competed intercollegiately, testing the assumption that biomotor differences would exist between them. La Place (1954) compared major league baseball players to class D minor league players on psychological variables and tested the
hypothesis that those baseball players who were considered successful (i.e., reached the major league) would have a different psychological profile than those players who were not as successful (minor league players). Olsen (1956) compared athletes who played varsity sports with those athletes who played intramural sports on measures of reaction time, expecting to find successful (varsity) athletes to have quicker reaction times than the non-varsity athletes.

Other studies have used coaches' ratings to differentiate between good and poor athletes. Everett (1952) used coaches' ratings to determine relative levels of baseball-playing ability in college varsity baseball players. Keller (1942) used coaches' ratings to determine relative levels of "athletic success" in different sports groups (baseball, basketball, football, etc.).

While generalizations concerning the relative differences in psychobiomotor characteristics between good or successful and poor or "unsuccessful" athletes are risky in light of these definitional differences, the many reports in the literature are nevertheless enlightening in that they provide an indication of those psychobiomotor characteristics that tend to differentiate between relative levels of athletic activity and/or ability.
Regardless of the different definitions of athletic success mentioned above, there have been basically three types of variables that have been used to categorize and define those characteristics of athletes that tend to differ at various relative levels of athletic achievement or ability. These are structural and biological variables, psychological variables, and perceptual-motor skill variables. The different types of characteristics are discussed separately in the following sections.

**Structural and Biological Variables**

There has been extensive research attempting to show that physical characteristics play an important role in athletic performance. In a study of 35 collegiate football lettermen, Carter (1968) found these athletes to be located at the 91st percentile in height and at the 94th percentile in weight when compared to a non-specified normative group, drawing the conclusion that gross size is an important characteristic of collegiate football players. In a study of 72 college varsity football players, Costill, Hoffman, Kehoe, Miller, and Myers (1968) reported that those athletes who were subjectively rated as "superior" (as opposed to average or inferior) by the coaching staff were significantly heavier than those less-successful (average or inferior) players. In a study comparing 102 male collegiate varsity baseball, basketball,
football, gymnist, tennis, and track and field athletes with a control group of 734 collegiate non-athletes, DiGiovanna (1943) determined that basketball and football players were significantly heavier than the control group. In addition, it was found that baseball, basketball, and football players had increased leg strength when compared to the norm group. It is unfortunate that DiGiovanna did not make comparisons between sports groups, since this information was available and could have provided an informative contrast among these athletic groups. Using a multiple regression analysis of 30 college varsity baseball players, Everett (1952) has shown that leg strength, as measured by the Sargeant Jump Test, was related to success (defined as playing ability based on the previous year's statistics). However, Everett did not describe how the various criterion measures were combined nor was there any report of the rationale for picking variables included in the regression equation. Thus, the reliability and replicability of the results are questionable. In a study of 100 wrestlers, Kroll (1958) found that the 24 successful athletes as defined by having won first or second place in the sectional or state tournament had significantly greater right and left hand grip strength and also greater back lift strength than those wrestlers categorized as unsuccessful (did not place in tournaments).
Aerobic power is the amount of energy that the body can produce for sustained physical effort for extended periods of time. It requires at least 5 seconds for the body to produce usable energy and is dependent upon the presence of oxygen in the bloodstream. Pargman et al. (Note 1) found in their study of 33 collegiate football players that aerobic power correlated negatively (-.37) with a measure of football-playing ability, indicating that those football players who were rated as having relatively more football ability tended to have less aerobic capacity than those rated lower in ability. One significant shortcoming in their study was the arbitrary and subjective nature that was utilized to determine football-playing ability. Another criticism was the statistically confounding effect of correlating a large number of variables when the number of subjects approaches the number of variables. Shirkey (Note 2) states that there should be at least twice as many subjects as variables, and as this assumption is violated, the correlation coefficients become confounded towards randomness. In Pargman et al.'s study there were 33 subjects and 34 variables.

Anaerobic power, in contrast to aerobic power, is a measure of the energy available to the muscles for short bursts of maximum physical effort. Caru, LaCoultre, Aghemo, and PineraLimas (1970) found in their study of 95
young) ages 14-18) non-professional soccer players that these athletes had significantly more anaerobic capacity than a non-specified norm group. It is interesting to note that in this study Caru et al. also found that aerobic power (mentioned above) did not differ from his normative group. This is not surprising, since Astrand and Rodahl (1970) state that "it is very rare that an individual possess top power for both aerobic and anaerobic processes" (p. 304). Thus, since these soccer players demonstrated increased anaerobic power, they would not be expected to also demonstrate increased aerobic power.

Deshaies (1978), in a study of 149 male ice hockey players participating in the Quebec Junior Major Hockey League, determined that those athletes who were rated by their coaches as having more hockey-playing ability also had increased anaerobic power and average amounts of aerobic power relative to those players who had less hockey-playing ability. Margaria, Aghemo, and Rovelli (1966) found in their study of 131 male and female subjects that anaerobic output (as measured by the step-climbing method described in this paper) for unspecified athletes was significantly higher than for non-athletes. Using the same technique, Costill et al. (1968) found in their study of 72 college football players that those players who were subjectively rated as superior by the
coaching staff had significantly higher anaerobic power than those players who were rated as inferior.

Whenever an attempt is made to determine the structural or biological characteristics of athletes, it must be realized that the total group of athletes includes a wide variety of skills and abilities needed; attributes required for one athletic position might not be needed in another. Therefore, when attempting to determine those biological and structural characteristics that distinguish among relative levels of ability in athletic performance, it is necessary to analyze the tasks that a particular position requires or type of athletic skills needed.

Pargman et al. (Note 1) cite Jokl who states that the type of tasks that a person performs relative to his athletic position will determine those physiological characteristics that best facilitate the completion of those tasks. Thus, those people that have the physiological characteristics required to more adequately perform those tasks will be more likely to be found succeeding in that sport. For example, football halfbacks frequently run with the football, usually at maximum speeds but typically only for a few seconds before being tackled. This indicates that for this task, halfbacks need to be able to produce a lot of energy in a very short period of time (a definition of anaerobic power). It can be seen that those athletes who
could produce relatively higher amounts of this type of energy would probably be more likely to be successful in this offensive halfback position than people who could not produce as much anaerobic energy, since these athlete's biological make-up is conducive to providing the physical requirements needed for the tasks involved.

From the above literature review it is apparent that the structural and biological characteristics have been extensively studied. However, as mentioned earlier, it is difficult to compare these findings due to the different criteria used to measure success. In light of these definitional differences, conclusions as to the structural/biological characteristics of athletes can only be general and tentative. In addition, the demands of a particular position within a particular sport will dictate those characteristics that are best suited for optimal performance in that position.

This research project was directed toward determining the psychobiomotor characteristics of collegiate offensive backfield (halfback, fullback, and quarterback) football players considered successful as determined by coaches' rating system used to differentiate relative levels of football-playing ability among subjects. Following Jokl's advice (Pargaman et al., Note 1), this research was therefore interested in those structural and
biological characteristics of offensive backfield athletes that differentiate among various levels of ability in this position. From the literature review, it can be seen that those football players who were considered "relatively better" (a more general descriptor that will be used to subsume terms such as superior, successful, and good) were heavier (Carter, 1968; Costill et al., 1968; DiGiovanna, 1943) than those football players who were not considered "better."

As mentioned earlier, offensive backfield players frequently run with maximum bursts of speed for short durations, a task which theoretically calls for high levels of anaerobic power. In support of this hypothesis is Costill's et al. (1968) study which determined that relatively better football players had increased anaerobic power. Another sport that requires tasks similar to offensive backfield football players relative to energy requirements is hockey, which requires players to skate at a fairly constant submaximal rate but frequently produce maximum physical efforts. Deshaies (1978) indicated that relatively better hockey players have increased anaerobic power. Also, Caru et al.'s (1970) study determined that better soccer players (in a game requiring frequent maximal bursts of energy) have increased anaerobic power. In light of the above findings, it was hypothesized that
relatively better offensive backfield football players possess increased levels of anaerobic power.

**Summary of Literature Review: Structural/Biological Characteristics of Athletes**

Although there are numerous reports of studies in the literature concerning the structural/biological characteristics of athletes, of particular interest in this study were those characteristics that appeared to be relevant to success (loosely defined as increased relative football-playing ability) in the offensive backfield football position.

No studies were found that investigated football-playing athletes in specific positions; the typical research modality has been to "lump" all individual positions together to determine the football athletic profile. Although this causes a gross overgeneralization of relevant characteristics between athletes in different within-sport positions, it was the best source of information available given the lack of position-specific research.

Two characteristics were consistently reported in the literature as being relevant to better football players: weight and anaerobic power.

**Psychological Variables**

There are numerous reports in the literature investigating the relationship between personality and athletic performance. However, due to the large number of
diagnostic instruments available, the differences in the level of maturity of the subjects, the wide range of applications, and the contradictory evidence obtained, interpreting the overall results has been difficult.

Singer (1975), in his book *Myths and Truths in Sports Psychology*, stated that research into the hypothesis that outstanding athletes possess personality traits that are dissimilar to those displayed by the average person or non-outstanding athlete are rather inconclusive (p. 93). In a study of 32 high school and college football players, Rushall (1970) determined that no significant personality differences, as measured by the 16PF, exist between players with differing relative levels of performance (as measured by whether the athlete was in a first, second, or third string position). Carlson and Kroll (1967) determined that no significant differences exist on personality traits measured by the 16PF between different levels of Karate skill (advanced, intermediate, or beginner, determined by belt color) among 71 amateur Karate participants. Lakie (1962) has determined that no significant differences exist between 230 male college basketball, football, tennis, and wrestling athletes as measured by the Omnibus Personality Inventory.

In spite of the above findings, several personality traits have appeared consistent across studies dealing with athletic ability in various sports.
Aggression/Dominance

The traits of aggressiveness and dominance are frequently reported as relating to athletic ability. In a study using the MMPI to compare the psychological profile of 78 college varsity football, basketball, wrestling, swimming, and track athletes against a normative group of 78 non-athletes, Booth (1958) found that the second order traits of dominance (Do) and anxiety (A) were significantly higher for the athletic group while the traits of social responsibility (Re) and masculinity-femininity (Mf) were significantly lower. In another study using the MMPI to compare athletes with non-athletes LaPlace (1954) found that 49 successful (as defined by playing in the major leagues) baseball players had significantly higher Hy (scale 3) and Ma (scale 9) scores relative to the norms provided for this test, which he interpreted as indicating an "aggressive, ambitious personality" (p. 318). In this study, LaPlace also compared these successful athletes with a group of 64 non-successful athletes (as defined by playing in the Class D minor league) and found the non-successful athletes to be significantly higher on the Pd (scale 4) and Sc (scale 8) scores relative to the successful athletes, indicating these unsuccessful athletes to be more unpredictable, erratic, antisocial, and impulsive than the athletes determined to be successful.
The Cattell 16PF psychological inventory has frequently been used to determine the psychological profile of athletes. Whiting, Hardman, Hendry, and Jones (1973), in a literature review of 42 studies using the 16PF to elucidate possible relationships between personality and performance in sport, found the typical athlete to be dominant and aggressive (E+), intelligent (B+), enthusiastic (F+), tense (Q4+), unstable (C-), undependable (G-), and to have a tendency towards suspiciousness (L+) when compared to the standardization population. Werner (1960) found in a study of 273 male cadets entering the United States Military Academy that those cadets who were considered athletes (had won secondary-school letter awards) were significantly more dominant (E+), sociable (A+), enthusiastic (F+), adventurous (H+), tough (I-), group dependent (Q2-), and conservative (Q,-) than those cadets with little or no prior participation in sports. In another study using the 16PF, Peterson, Weber, and Trousdale (1967) found 97 superior (U.S. Olympic team) female athletes to be different from the norm group (as reported by Cattell for this test) in that the athletes were more aggressive (E+), intelligent (B+), and suspicious (L+).

In a study using the Edwards Personality Preference Schedule (EPPS) to test 950 freshmen male college physical
education majors, Fletcher and Dowell (1971) found that those subjects who had participated in high school athletics were significantly more aggressive and dominant than those students who had not participated in high school sports. Also using this test, Singer (1969) found that 10 tennis players scored significantly higher on the aggression trait than the normative population and also scored higher than 26 baseball players on dominance.

Other tests besides the MMPI, 16PF, and EPPS have been used to study athletic personalities, but with much less frequency. Ogilvie and Tutko (1971), in developing the Athletic Motivation Inventory, tested over 15,000 athletes (non-specified) and have determined that a general sports personality does exist. This personality is comprised of the traits of aggressiveness, conservativeness, self-sufficiency, and a high need for achievement. Johnson, Hutton, and Johnson (1954) found in a study using the Rorschach and the House-Tree-Person (H-T-P) that All-American or national champion athletes (sports not specified) were characterized by the personality traits of aggressiveness, freedom from emotional inhibition, high levels of tension and anxiety, and self-assurance. These results should be viewed tentatively, however, since these tests are subjective in nature and were scored by only one person; therefore, the reliability is questionable.
Adventurousness

The trait of adventurousness has also been frequently associated with athletic achievement. Langer (1966), in a study that used the 16PF to test 55 college football players, found that those players who were subjectively rated by coaches as having relatively more football-playing ability were characterized by the traits of adventurousness (H+), emotional stability (C+), tough-mindedness (I-), confidence (O-), conservativeness (Q1), and compulsiveness (Q3+). Foster (1977), also using the 16PF, found in a study of 483 male high school athletes in football, basketball, baseball, and track that those football players who were rated outstanding or successful by coaches' ratings of their previous year's performances were significantly more adventurous (H+) and enthusiastic (F+) than those players who were rated as unsuccessful. Werner and Gottheil (1966), in a study of 454 cadets entering the U.S. Military Academy, found that those players who were athletes in high school were determined by the 16PF to be significantly more adventurous (H+), sociable (A+), enthusiastic (F+), conservative (Q1-), group dependent (Q2-) and tense (Q4+) than those cadets who did not participate in high school athletics. As mentioned earlier, Werner (1960) also found his subjects to be adventurous (H+).
Conservativeness

King and Chi (1974), in a study using the 16PF to measure the personality characteristics of 48 male athletes (defined as having won a varsity letter in an intercollegiate sport) and 45 non-athletes (had never participated in intercollegiate sports) found that the athletes were more conservative (Q₁⁻), conscientious (G+), practical (M⁻), and group dependent (Q₂⁻) but less intelligent (B⁻) than the group of non-athletes. Straub and Davis (1971) used varsity college football players from a small, private college (n = 50), an Ivy League University (n = 69), a small state supported school (n = 44), and Big 10 schools (n = 83) as criteria for different levels of football competition. Profiles, as measured by the 16PF were compared and it was found that the Big 10 football players (considered the most successful) were more conservative (Q₁⁻), conscientious (G+), and practical (M⁻), than the other three levels of competitors. Also, as mentioned earlier, Ogilvie and Tutko (1971), Werner (1960), Werner and Gottheil (1966), and Langer (1966) found conservativeness to be a significant factor in describing athletes in their studies.

Tension/Anxiousness

Malumphy (1968), in a study using the 16PF to test 77 athletic females (tennis, golf, fencing, swimming,
archery, basketball, and softball) and 42 non-athletes, found that the basketball, field hockey, and softball players (team athletes) were more anxious ($Q_4^+$), but less extroverted ($A^-$) and emotionally stable ($C^-$) than the individual team athletes. In addition, as cited before, Werner and Gottheil (1966), Johnson et al. (1954), Whiting et al. (1973), and Booth (1958) all found anxiousness or tension to correlate positively with athletic performance.

**Enthusiasm**

In the Handbook for the 16PF, Cattell, Eber, and Talsuoka (1974) state norms for athletes in which they indicate swimmers and college football players to be characterized by both high levels of enthusiasm ($F^+$) and dominance ($E^+$). Werner (1960), Werner and Gottheil (1966), Foster (1977), and Whiting et al. (1973) also showed athletes to have higher levels of enthusiasm when compared to non-athletes or less successful athletes.

**Summary of Literature Review: Personality Characteristics of Athletes**

Although there has been much contradictory evidence in the area of a "sports personality" (Singer, 1975, p. 93), several personality traits have appeared to be somewhat consistent across studies dealing with athletic ability. As reported above, these studies indicate the athlete to be relatively more aggressive and dominant,
adventurous, conservative, tense, and enthusiastic than the less successful athlete or non-athlete. It may be that these personality traits are instrumental in motivating certain individuals to participate in sports, and that these traits contribute to make some people persist long enough to become successful (Deshaies, 1978).

**Perceptual and Motor-Skill Variables**

Variables, such as reaction time, visual abilities, and running speed, have often been examined to determine their relationship to athletic performance. In a study of 20 male racquet game players who were international competitors in squash and badminton, Knapp (1961) found reaction time (as measured by the length of time required to remove a finger from a telegraph key in response to a light stimulus) to be significantly faster than the control group of 20 matched research students. Using a similar method for measuring reaction time, Burley (1944) found that of 56 male college varsity athletes football backs produced the second fastest reaction time, being faster than basketball players, swimmers, high school sports letter winners, football linemen, and non-athletes; they were slower only to baseball players. Olsen (1956) studied three levels of athletic participation (college varsity sports winners, \( n = 100 \); intramural sports participants, \( n = 100 \); and non-athletes, \( n = 100 \)) and found
that reaction time as measured by the Stoelting Visual Reaction Time (also a telegraphic key device), was significantly faster for the athlete group when compared to both the intramural and the non-athlete group. Olsen also found depth perception, as measured by the Howard Dolman Apparatus, to be significantly better as athletic involvement increased; finally, it was determined that Span of Attention (as measured by a tachistoscopically-presented series of 200 slides displaying various numbers and arrangements of dots) was significantly better for the varsity athletic group than for either of the other two groups. Beise and Peasely (1937) found in their study of 47 college women, who had demonstrated skill in a tennis, golf, or archery class and 14 uncoordinated female students (both groups placed in these categories by their physical education instructors) that reaction time as determined by measuring the latency period from a visual cue to run and the actual initiation of the run was significantly faster for the skilled athletes. They also discovered running speed (for a distance of 27 feet [8.23 m]) and agility (the ability to run a zig-zagged course) to equally discriminate the faster and more agile skilled athlete from the uncoordinated students. Winograd (1942) tested 45 high school baseball players, 47 college baseball players, 20 rejected candidates for varsity college baseball, and 49 college non-athletes on measures of
"quickness of body movement" (as measured by the Keller Timing Instrument, which uses illuminated arrows to indicate to the subject whether to run to the left, the right, or forward a distance of one extended arm length) and found that the varsity baseball players had significantly faster body movement than the rejected candidates or the non-athletes. Using this same test, Keller (1942) studied 359 high school and college sports squad members and 277 non-athletes and concluded that the athletes were significantly quicker than the non-athletes. Also, coaches' ratings were used to determine a measure of athletic success and found a significantly positive relationship between the ability to move the body quickly and success in athletic activities. Finally, baseball, basketball, football, and track athletes were significantly quicker than gymnasts, swimmers, or wrestlers, indicating that quickness of body movement is not the same for all sports.

Related to quickness of body movement is the motor trait, speed. Brace (1943) found in a study of 65 varsity college football tryouts that the 50 yard dash and the zig-zag run correlated significantly with football-playing ability as determined by coaches' ratings. Highmore and Taylor (1954) found in their study of 110 eleven-year-old school boys that the 50 yard dash, the
high jump, and the soccer ball kick correlated significantly with coaches' ratings of their overall performance in physical education classes. As mentioned earlier, Beise and Peasely (1937) also found running speed to correlate with athletic ability.

Visual abilities have often been shown to correlate with athletic ability. Gavriyski (1969), in a discourse on vision in sport, reported that man experiences about 85% of his information visually. Low (1946), in a study of the effects of visual training, found that the training of photopic (daytime) visual acuity increased this acuity by 334% in 43 college subjects. Graybiel, Jokl, and Trapp (1955) have reported that Olympic athletes (type and number unspecified) have greater depth perception as measured by the Howard Dolman Apparatus than untrained control subjects. As noted previously, Olsen (1956) determined that college varsity athletes had greater depth perception than intramural athletes.

In the study attempting to determine norms for peripheral visual acuity, Low (1943) examined 100 randomly picked college students and produced a wide variability; the mean of all obtained scores was equated to 100%, and the range of scores was from 43% to 364% of peripheral visual acuity. Williams and Thirer (1975) have found, using the Bausch and Lomb perimeter, that a group of 32
male and female athletes (football, fencing, and tennis) had significantly increased horizontal and vertical fields of vision relative to a control group of 50 male and female non-athletes. There were no significant sex differences. Finally, Pargman, Schreiber, and Stein (1974) have shown that athletic subgroups perform differently on a visual disembedding task (the Group Hidden Figures Test). Fifty-one team sports participants (baseball, football, and hockey) scored significantly higher than 60 individual sports participants (gymnastics, track, swimmers, wrestlers) on this task, indicating that team sportsmen are more field-dependent than individual sportsmen. In addition, the football players scored the highest of all groups, regardless of whether they were a team or an individual participant.

One factor that has received very little attention in the literature in relation to athletic ability is pain tolerance. Many sports involve a high probability of sustaining injury, such as football, hockey, and basketball. Ryan and Kovacic (1966) reported that of 20 contact sport athletes (football, wrestling, and boxing), 20 non-contact sport athletes (golf and tennis), and 20 non-athletes, the contact sports athletes tolerated more pain than the non-contact sport athletes or the non-athletes. Pain was administered by pressing a football
cleat against the tibia bone in the leg and increasing pressure with a blood-pressure cuff. In addition, Deshaies (1978) reported in a study of 149 young (ages 15 to 19) male hockey players that successful players (as determined by an average of 5 different coaches' ratings) had higher pain tolerance relative to the general population.

Summary of Psychobiomotor Characteristics of Athletes

It can be inferred from the literature review that the structural/biological variables of weight and anaerobic power consistently discriminate between relative levels of football-playing ability. The psychological variables aggressiveness, adventurousness, conservativism, tenseness, and enthusiasm appear to describe the personality of the individual who has relatively better athletic ability. It should be noted, however, that relatively few of these studies dealt specifically with football players and none of them further delineated the football players into specific positions. Finally, the perceptual motor traits reaction time, visual abilities, and running speed were shown to correlate with athletic success, and, in a few cases, with success in football.

There have been many attempts to identify the physiological, psychological and motor-performance variables that discriminate between the successful and unsuccessful
athlete. There are several major criticisms of previous attempts to identify the salient qualities of successful athletes. The first relates to the choice of criterion used (athlete vs. non-athlete, differences between athletic sub-groups and differences in level of competition). Although these criteria are readily available and relatively easy to use, the question remains "Does this criterion really measure what is desired?" It could be that intervening variables affect the criterion score; for example, in a collegiate or professional football team--does a difference exist between a full-time starter and a player who sits the bench every game? Both have reached a level of ability and motivation to at least make the team, but one clearly plays more often than the other, suggesting differences between the two. However, in the typical criterion measure of level of competition, both would be treated equally as far as the criterion measure goes.

Another criticism of previous attempts to predict athletic potential is the seemingly haphazard way in which investigators determined the variables to be measured. Known as the "shotgun approach," many investigators seem to throw many variables into the research "pot," hoping to find something that correlates significantly with the measure of success. An example of this is Pargman et al.'s (Note 1) study in which they included 34 variables.
Research theory indicates that if one "shoots enough shot often enough, you are bound to hit something. Give many tests and scales to a group of individuals and you are bound to get some significant, even substantial correlations" (Kerlinger & Pedhazur, 1973, p. 442).

Another criticism of previous research is the lack of any systematic analysis of the athletic position to be predicted in order to identify the salient aspects of that position. There is a frequent tendency to lump all positions together to come up with a football, baseball, etc. type of personality and skill characteristics. This leads to a gross overgeneralization of relevant skills to different positions within a sport. The relative skills, abilities, and personality characteristics required by a halfback are quite different from those required by a placekicker or a defensive lineman.

This study was designed to address the shortcomings mentioned above. Relative to the choice of criterion measures, an attempt was made to develop a measure as close as possible to the "ultimate criterion" (Guion, 1965), which is described as the overall contribution of factors involved relating to success. A systematic effort was undertaken to determine the numerous variables and their relative contributions that lead to success in the offensive backfield position. It was expected that
this would provide a wider range of criterion scores, thus enabling more discreet discriminations of ability than would a simple coach's rating or even the less variable dichotomous criterions of athlete - non-athlete or levels of competition. By improving this criterion measure, it was hypothesized that the predictive power of the variables chosen would be improved and the likelihood of improving the correlation over typical studies in the literature would be greatly enhanced.

A systematic task analysis was undertaken for the offensive backfield position to help narrow the list of possible variables from a large one to a more practical and research-wise compilation of characteristics to be studied. The variables included were kept to a minimum and were included based on an evaluation of their relative importance to the particular position in question. The skills and attributes included in this study were anaerobic power (a structural/biological variable), running speed, pass-receiving ability, and perceptual-and-motor speed (motor-skill variables), and dominance, adventurousness, conservativism, and tenseness (psychological variables). It was hypothesized that a combination of variables from each of the three categories (psychological, biological/physiological, and motor skill) would correlate significantly with football-playing ability as measured by coaches' ratings. Specifically, it was
hypothesized that tryouts for the collegiate offensive backfield position who had relatively more anaerobic power, could run short distances faster, had relatively more pass-receiving ability, had relatively faster perceptual-and-motor speed performance capabilities, and were more dominant, adventurous, conservative, and tense would be rated as having more football-playing ability than tryouts with relatively less of these desired attributes and skills, since these variables were hypothesized to be important in determining football-playing ability in the offensive backfield position. Thus, there should be significant psychobiomotor differences between successful collegiate football players in this position and those players who were rated as less successful in this position.
METHOD

Subjects

The subjects for this study were male volunteer try-outs for the offensive backfield position on the inaugural University of Central Florida football team. The average age of the subjects was 20.5 years with a range from 18 to 24; the average weight was 180.37 lbs (81.82kg) with a range of 145 lbs (65.78kg) to 220 lbs (99.79kg). The purpose of the experiment was explained to those who tried out for this position, and their participation was requested. Additional information was provided as follows and they were asked to acknowledge their agreement through signing an informed consent sheet:

1. Permission for psychological testing and an assurance that the psychological profile:
   a. would not be used in any manner except for the purposes of the research project, and
   b. would not be available to anyone other than the experimenter;

2. A statement permitting them to be tested under stress conditions;

3. An assurance that the data collected would be used only for research purposes and would not be made available to the coaches for use in the selection and retention of the football players;
4. A statement releasing the experimenter, coaching staff, athletic department, psychology department, and university from responsibility due to accidents occurring during testing; and

5. A statement allowing the subject to withdraw from the research at any time, for any reason, without penalty, punishment, or derogatory consideration from either the experimenter or the coaching staff.

A copy of the informed consent appears in Appendix A.

Analysis of the Offensive Backfield Position

A systematic analysis of the tasks required in the offensive backfield position was undertaken in order to ascertain the skills, abilities, and personality characteristics required to be considered superior. Interviews were conducted with coaches, players, and other persons knowledgable about the position in order to determine those salient qualities. From this task analysis 15 constructs were identified as important to this position, and a measure of the relative importance was obtained by asking those people involved in the analysis to rate each dimension on a five-point scale.

The results of this task analysis (the characteristics determined to be relevant to this position), the form used to determine their relative importance, and the assigned weights (the average of their ratings) can be seen in Appendix B.
Measurements

Data were collected on three categories of variables: physiological, psychological, and perceptual-motor variables related to the offensive backfield playing position. Included in these three categories were eight variables hypothesized to be significantly correlated with football playing ability.

Physiological Variable

Maximum Anaerobic Power, as stated before, is the maximum amount of energy that the body can provide in a very short period of time. It was determined by the method described by Magaria, Aghemo, and Rovelli (1966) and modified by Costill, Hoffman, Kehoe, Miller, and Myers (1968), based on the idea that the energy provided the muscles during the first four-five seconds is not due to either the presence of oxygen in the muscles or the lactic acid formation from glycogen, which are delayed processes and do not contribute an appreciable amount of energy during this initial period. The energy expended during this initial four-five second burst of maximal activity far exceeds the body's capacity to supply the active tissues with sufficient oxygen needed for the metabolism of glycogen. Therefore, the active tissues receive their energy from the splitting rate of the high-energy phosphate compounds present in the muscles, since
this process can take place at a higher rate than oxidative metabolism.

In this study anaerobic power was defined as follows: the subjects were instructed to run up a flight of stairs two steps at a time while running at maximum effort. The time required to cover four jumps (eight steps) was measured by an electronic timer (Cronus Olympian \textsuperscript{TM} Single Event Timer), accurate to .01 second. A starting line was placed two meters from the first step, and an electronic timer pad was placed on the fourth step (used to start the timer). Another timer was placed on the twelfth step to stop the timer.

The detailed instructions given each subject were:

Run as fast as you can up this flight of stairs, two steps at a time. You will be timed to see how long it takes you to do this, so run at your maximal speed. After you are positioned behind the starting line, you may start any time you want. Remember---run as fast as you can and do not slow down until you reach the top of the stairs. Do you have any questions?

Subjects were given two practice trials, and two timed trials. The fastest time was used for statistical analysis.

It has been determined that if the incline of the steps exceeds 30\%, then all appreciable external work is due to body lift alone (Margaria, Aghemo, \& Rovelli, 1966), with other factors such as speed changes at each
step, etc., being negligible. Therefore, by dividing the vertical dimensions between the fourth and the twelfth steps by the time required to run this distance, the vertical velocity can be determined. If the vertical velocity and the subject's body weight is known, it is possible to determine his mechanical work output (in energy expended) by the following formula (Coleman, Kreuzer, Friedrich, & Juvenal, 1974): Anaerobic Power (in Kilocalories/Min) = 
\[0.0778 \left( \frac{w \times d}{t} \right)\]
where \(w\) = body weight in pounds, \(d\) = vertical distance between the fourth and the twelfth steps, measured in feet, and \(t\) = the time required to travel that distance, measured in seconds. The subject's weight was determined by a Detecto™ Portable School Scale, Model 138W.

Psychological Variables

The Cattell 16PF (form A) was administered in a group setting. For the purpose of this study, only the following scales were used to predict football potential:

<table>
<thead>
<tr>
<th>high score</th>
<th>low score</th>
</tr>
</thead>
<tbody>
<tr>
<td>(E) dominant/aggressive vs. submissive</td>
<td></td>
</tr>
<tr>
<td>(H) adventurous     vs. timid</td>
<td></td>
</tr>
<tr>
<td>(QI)experimenting  vs. conservative*</td>
<td></td>
</tr>
<tr>
<td>(Q4)tense          vs. stable</td>
<td></td>
</tr>
</tbody>
</table>

*Note that high conservativism is a low score on this scale.
A review of the extensive sports personality research has not conclusively supported the idea that there is a certain athletic personality; the results are at best equivocal. However, since the four personality traits listed above have been more consistently shown to occur in successful athletes with fewer contradictory findings, it was hypothesized that persons with those personality characteristics would have more football playing potential than those without those characteristics.

The standard instructions for administration of the 16PF were utilized. The subjects were not timed, and were allowed to answer at their own pace. As stated earlier, the subjects signed a release form which stated that this information would not be divulged to anyone not directly involved in the research project; the coaches did not have access to this information for use in their evaluations of the prospective team-members. This release form was counter-signed by the experimenter with the hopes of assuring the subjects of this confidentiality, thereby obtaining a more reliable personality assessment.

**Motor Skill - Performance Variables**

**Speed.** Time required to run 10 yards (9.14m) was measured in hundredths of a second by a Cronus Olympian™ Single Event Timer. The subject started from a three-point stance and responded to an auditory cue provided by
a cassette tape on which an irregular cadence was recorded. The head football coach determined that the irregular cadence was to be the most frequently used during actual game situations. On the tape at the point of the designated cue (the call which was the cue for the subject to start running) a sensory strip was located which activated the electronic timer. The subject stepped on an electronic timing pad at the end of the 10 yards, which disengaged the timer. The subjects were told what the starting cue was, and were allowed to hear the tape twice in order to familiarize themselves with this cue. Two timed trials were given, with the fastest time being used in the statistical analysis.

The subject was given the following instructions:

A taped cadence will be played on this tape player, and when you hear the starting cue, you are to run as quickly as you can this 10-yard distance and stop the timer by stepping on the timing pad at the finish line. Do you have any questions?

Pass-Receiving Ability. Pass-receiving ability was assessed by having a quarterback throw passes to the subject, who was stationary and located five yards (4.57m) away from the passer. Eighteen passes were thrown in a random order into sections located as shown in Figure 1.
Figure 1. Locations of the sections for the pass-receiving subtest.

The passer was trained to throw into these sections with consistent speed in order to keep the difficulty factor equal across all subjects. An administrator was present to show the passer into which segment to throw the ball (by pointing to the desired segment on the figure shown above, with the figure hidden from the subject's view), and also to determine if the ball accurately entered the desired area. In the event that the passer missed the desired area, the ball was simply thrown again, although never into the same area consecutively. The score on this test was the number of throws caught.

The subject was given two trials with the scores on the two trials summed and recorded. The trials were given consecutively.
The subject was given the following directions:

*Your are to stand on this mark on the ground, and when the passer throws the ball, you are to try to catch it. He is going to throw the ball high, low, to the left, and to the right. Try to catch as many passes as you can. Do you have any questions?*

**Perceptual and Motor Speed.** This test was designed to assess the player's ability to see "holes" in the line and to proceed quickly to those areas; furthermore, the ability to make several such discriminations quickly and to perceive the matrixed field as a Gestalt were also factors loaded on this test.

For this test, a field was laid out in a matrix of markers (highway plastic lane markers, three feet [0.91m] in height) which were located three yards (2.74m) apart from each other, with five markers per row and four rows deep. A partition was located three yards (2.74m) before the first row and a finishing line was located three yards (2.74m) past the last row.

In each row, one marker was distinguished by a four foot (1.22m) high orange-painted wooden pole. The view of the field and the markers was blocked by the use of partitions, measuring 24 feet (7.32m) in length and 10 feet (3.05m) in height, placed so that the subject was not able to see the marker pattern before he ran the test. The partitions had a four-foot (1.22m) opening
through which the subject ran. The starting line was located two yards (1.83m) to the right of the opening in the partitions, looking out towards the markers. The starting line was perpendicular to the partition and located two feet (.61m) out from the partition.

The subject began from a crouched position with his forearms resting on his thighs just superior to his knees on his quadracep muscles, with his shoulders parallel to the starting line. The subject carried a football during this exercise. The subject responded to a cue provided by a cassette player on which an auditory cadence was recorded. This cadence was the same as used in the speed test. A sensory strip was located on the tape at the point of the auditory cue which was used to activate an electronic timer (Cronus Olympian™ Single Event Timer). When the subject heard this auditory cue, he ran through the opening in the partition, found the designated marker in the first row, ran to it and touched it, found the designated marker in the second row, ran to it and touched it, and continued this procedure through all the rows, and finally sprinted through the area designated as the finish line, thus disengaging the timer by stepping on the electronic timing pad.

All subjects were given two timed trials with the designated marker's positions in each row changed for each set of trials.
The subjects were given the following instructions, while being shown the field matrix:

You will be asked to run through this field as fast as you can after hearing the auditory cue. As you run through the opening in the partition, you are to find the marker in the first row of markers that has a colored stick in it, and run to it as fast as you can. After touching the stick with either hand, you are to find the colored stick in the second row and run to it, touching it as you pass it. You are to continue until you have touched all four markers. After you have done this, run as quickly as you can to the finish line and step on the electronic timing pad to disengage the timer. Remember, you are to run as fast as you can carrying the football, you are to touch all designated markers, and you are required to step on the timing pad as you cross the finish line. Do you have any questions?

Figure 2 shows the layout of the field matrix, the location of the partition, the starting and finishing lines, and the positions of both trials marked. Before the subjects were initially shown the field matrix (while being given the instructions), the locations of the markers were changed so that they would not know the locations as they ran through the opening on the first trial. They were instructed that the marker positions would change for both the first and second trials.

Football-Playing Ability (criterion variable)

At the end of the football season, a checksheet was given to three coaches, all of whom were offensive backfield coaches, for every person who tried out for the offensive backfield position. This checksheet was comprised
Figure 2. Field layout for the perceptual-motor test.
of the skills determined to be important in this position. The form used to evaluate these players can be found in Appendix C. Each of the three coaches was also given a checksheet to rate the relative importance of each skill; weights were assigned to each skill relative to the importance of each one in the offensive backfield position as determined by an average of the three ratings.

Therefore, the skills that were deemed more important to football-playing ability had more bearing on the final determination of the criterion variable than those skills that were determined to be not as important.

To determine the football-playing ability of each player, the three coaches filled out a checksheet for every player in this position. Football playing ability was the weighted mean of scores assigned to a player by the coaches.
RESULTS

The mean, standard deviation, range, and number of subjects for each measure are presented in Table 1. A complete set of scores for each of the nine measures was not collected for all subjects. Three subjects missed two subtests; three other subjects missed on subtest. In these cases where a subject missed a particular subtest, he was assigned the mean for this measure.

Validity coefficients for the anaerobic subtest range from .72 to .82 when compared to other measures of anaerobic power (Deshaies, 1978). Since Margaria et al. (1966) report high reliability without reporting specific coefficients, the test's reliability was determined by comparing the first and second trials summed and averaged across all subjects. The test-retest method was used to determine the reliability estimate, $r = .92$, $p < .0001$.

Test-retest reliability for the speed subtest was determined by correlating the first and second timed trials across all subjects, $r = .50$, $p < .05$.

Reliability for the pass-receiving subtest was determined by the split-half method, $r = .63$, $p < .005$.

Test-retest reliability for the perceptual-motor subtest was determined by correlating performance on the
Table 1
Mean, Standard Deviation, Range, and Number of Subjects for All Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Football Receiving</td>
<td>12.37</td>
<td>1.80</td>
<td>8-15</td>
<td>19</td>
</tr>
<tr>
<td>10 yard dash</td>
<td>1.84</td>
<td>.15</td>
<td>1.51-2.01</td>
<td>16</td>
</tr>
<tr>
<td>Perceptual-Motor Run</td>
<td>7.34</td>
<td>.72</td>
<td>5.96-8.39</td>
<td>16</td>
</tr>
<tr>
<td>Anaerobic Power</td>
<td>64.74</td>
<td>5.68</td>
<td>56.45-75.12</td>
<td>16</td>
</tr>
</tbody>
</table>
first trial with that on the second trial across all subjects, \( r = .88, p < .001 \).

Test-retest reliabilities for the psychological variables as reported by Cattell et al. (1974) are:

(E) dominant/aggressive vs. submissive (.65)
(H) adventurous vs. timid (.80)
(Q₁) experimenting vs. conservative (.50)
(Q₄) tense vs. stable (.66)

A correlational matrix was computed for all possible pairs of variables in order to examine the intercorrelations among the predictor variables and the relation of each predictor to the criterion variable. Results are presented in Table 2. Football-receiving ability correlated .62 with the criterion, while the 16PF trait \( Q_1 \) correlated -.62, indicating the conservative end of the continuum correlates with football-playing ability. In addition, anaerobic power correlated .46 with the criterion.

The Maximum \( R^2 \) Improvement multiple regression technique (Barr, Goodnight, Sall, & Helwig, 1979) was utilized to overcome the shortcomings of the other various types of multiple regression, such as the forward selection method's inability to remove a previously entered variable found at a later stage to add an insignificant amount of variance, or the inability of the stepwise regression method to evaluate the effect of adding a variable outside
Table 2

Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>IOyd</th>
<th>Prom</th>
<th>Anrbc</th>
<th>E</th>
<th>H</th>
<th>Q₁</th>
<th>Q₄</th>
<th>Crit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fbrc</td>
<td>-.55**</td>
<td>-.22</td>
<td>.35</td>
<td>.14</td>
<td>.22</td>
<td>-.34</td>
<td>-.09</td>
<td>.62***</td>
</tr>
<tr>
<td>IOyd</td>
<td>.12</td>
<td>-.20</td>
<td>.10</td>
<td>.14</td>
<td>.03</td>
<td>.22</td>
<td>-.21</td>
<td></td>
</tr>
<tr>
<td>Prcm</td>
<td>-.37</td>
<td>.44</td>
<td>.04</td>
<td>.29</td>
<td>.32</td>
<td>-.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anrbc</td>
<td>-.10</td>
<td>.26</td>
<td>-.24</td>
<td>-.23</td>
<td>.46*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.64***</td>
<td>.38</td>
<td>-.28</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.09</td>
<td>-.56**</td>
<td>.34</td>
</tr>
<tr>
<td>Q₁</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.04</td>
<td>-.62***</td>
<td></td>
</tr>
<tr>
<td>Q₄</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.01</td>
<td></td>
</tr>
</tbody>
</table>

Note: Fbrc = football-receiving ability
IOyd = speed (10 yard run)
Prom = perceptual-motor run
Anrbc = anaerobic power
E = dominant/aggressive vs. submissive
H = adventurous vs shy
Q₁ = experimentative vs. conservative
Q₄ = tense vs. relaxed
Crit = criterion (football-playing ability)

* p ≤ .05
** p ≤ .02
*** p ≤ .005
of the present model when removing a variable currently in the model. The $R^2$ technique computes every possible combination of an "n" variable regression, thereby producing the highest $R^2$ statistic for that number of variables. Therefore, it does not settle on a single model as do other forms of multiple regression but considers the effect of adding the next best variable when removing the worst variable in a given model. This technique uses the principle of "meaningfulness" to establish statistical significance, a method recommended by Kerlinger and Pedhazur (1973, p. 286). Prior to analysis, it was determined that variables which provided five percent of the variance in explaining football-playing ability would be retained.

Table 3 presents the analysis obtained. This analysis explains the relationship of the best linear composite of the predictor variables with the dependent variable. It can be seen that four variables (conservativism, pass-receiving ability, aggressiveness, and anaerobic power) contributed significantly to the regression equation, accounting for 68% of the variance in predicting football-playing ability, $t (17) = 8.81, p < .005$. The beta weights in the regression equation indicate the relative contribution of each variable in predicting football-playing ability; the largest weight was assigned to the
Table 3
Maximum $R^2$ Improvement Analysis--Summary Table

<table>
<thead>
<tr>
<th>Step</th>
<th>Variable Entered</th>
<th>$R^2$</th>
<th>Significance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$Q_1$ (conservativism)</td>
<td>.39</td>
<td>$p$ .005</td>
</tr>
<tr>
<td>2</td>
<td>Football Receiving</td>
<td>.57</td>
<td>$p$ .005</td>
</tr>
<tr>
<td>3</td>
<td>$E$ (aggressiveness)</td>
<td>.63</td>
<td>$p$ .005</td>
</tr>
<tr>
<td>4</td>
<td>Anaerobic Power</td>
<td>.68</td>
<td>$p$ .005</td>
</tr>
</tbody>
</table>

Football-Playing Ability = .317 (Fbrc) + .082 (Anaerobic)  
+ .260 ($E$) - .715 ($Q_1$) + 8.21
psychological variable $Q_1$, which indicates that players who score low (are highly conservative) are rated as having higher football-playing ability. The other three variables, in descending order of influence, were football-receiving ability, aggressiveness, and anaerobic power. At least one variable from all three psychobio-motor categories was included.
DISCUSSION

The hypothesis that a combination of psychological, biological, and motor-skill variables would correlate significantly with football-playing ability was confirmed. Support for this hypothesis suggests that a multitude of factors contribute to provide the motivation and capabilities required to propel a person into success. The literature review indicated that most of the attempts to predict success or to define the characteristics of athletes were confined to one or at most two of the three categories included in this study (psychological, biological, and motor-skill attributes). Singer (1980) states that performance is a result of the following formula: performance = motivation x capabilities. Motivation is a difficult construct to measure, and problems are abundant in the clinical sphere relative to instruments capable of reliably discerning this personality trait. Since an instrument that satisfied the requirements of this research was not available, other constructs which could measure the psychological make-up of the football prospect were utilized. The literature indicated that successful football players were conservative, aggressive, adventurous, and tense, it was hypothesized that these variables could "set the stage" for someone
to be motivated to persist long enough at this task to succeed.

In this study, the inclusion of the psychological variables aggressiveness and conservativeness indicate that successful offensive backs not only have the courage and competitiveness to strive for success, but also have the ability to respect and submit to authority, a factor that could be beneficial to the player in that it could provide the mechanism to cope with the rigors of training and long hours of grueling practice, frequently being subjected to coaching styles that humiliate or anger the players in order to motivate them to strive harder. The traits of aggressiveness and conservativeness could predispose and motivate an athlete to not only strive harder but also provide a mechanism to deal with the rigors of training.

The second factor in Singer's (1980) formula (performance = motivation x capabilities) includes one's abilities, one component of which is a product of past experiences and interests. What is frequently overlooked in past attempts to predict athletic performance is the biological aspects of a player, or the physical limitations on performance that a person's body sets. It does not take too much inspection to realize that one's performance on a motor task is limited to his biological
capabilities (for example, the amount of energy his body can produce, his structural make-up, and so on) and his past learning experiences and interests. Therefore, it becomes apparent that not only are psychological and motor-performance variables important in determining athletic performance, but biological capabilities are equally determinant of behavioral outcomes.

The inclusion of the biological variable anaerobic power indicates that an athlete's genetic make-up plays a significant part in providing him with the physical requirements for an activity. An offensive back is required to produce maximum effort in a very short amount of time and usually for only a few seconds duration; this corresponds to the definition of anaerobic power. Those football prospects who have the genetic predisposition for greater amounts of anaerobic power would more likely be found to be succeeding in that position or in tasks requiring that attribute, as was found in this study.

The inclusion of the motor-performance variable football-receiving ability indicates that tryouts who have had past experience and/or the natural ability to quickly perceive the direction and location of a thrown football and to be able to catch and hold onto it regardless of whether it was thrown accurately are more likely to be considered successful. From an inspection of the tasks
that an offensive backfield player is required to perform, pass-receiving is one of the most important he carries out.

Although a substantial 68% of the variance in football-playing ability ratings was accounted for by these four variables, a large proportion of what contributes to success remains unexplained. Running speed correlated negatively \((r = -0.21)\) with football-playing ability. This seemingly indicates that successful backs are slower in running ten yards than unsuccessful backs. There are several possible explanations for this result. The variance in running times from the average (mean) speed on this subtest was \(0.0225\) seconds, a small difference which did not allow for discrimination among athletes. Therefore, the nonsignificant negative correlation between running speed and football-playing ability could be an artifact of the small variance obtained on this measure.

Another possible explanation for this variable not entering the regression equation is that on the day that this and the other motor-performance subtests (pass-receiving ability and perceptual-motor run) were administered, a mid-afternoon rain shower occurred. The resultant wet field could have influenced some of the runners in that their footing and traction could have been affected. Some of the players ran on a dry field; some ran after the rainfall. This moderator effect could not be
factored out due to the lack of foresight to identify those players who were subjected to the wet field conditions. Finally, running speed might not have entered the regression equation due to the significant correlation between this variable and football-receiving ability, $r = -0.55, p < 0.02$. Thus, the covariation between these two variables might be such that the variance predictor variable speed accounts for in the criterion could be accounted for already in the variable football-receiving ability. Since the correlation between these two predictors is high and significant, this possibility is not unlikely.

The predictor variable perceptual-motor speed also did not enter into the regression equation. This could be due to a lack of familiarity with the task requirements. Originally this subtest was designed so the subjects would have two practice trials. These trials were abandoned for all subjects because of the weather conditions and reduced time. Another possible explanation is the limited variance on the obtained speeds for this test (.52 seconds), which limits the discrimination power of these scores. Again, as mentioned above, some players ran on a wet field and some on a dry field; this could have affected the results. Another possible reason for this variable not entering the regression equation is the fact that three of the subjects did not complete this
subtest. In order to conduct the statistical analysis, these subjects were assigned the obtained mean value as a score on this test. The rationale for this procedure is that the mean score is the best estimate of a person's true score (Ferguson, 1976). One result of assigning the mean, however, is that it by nature places a restriction, or limits the variance of scores obtained, which results in reducing the discrimination power as mentioned above.

Although there was a relatively high correlation between the psychological construct of adventurousness and football-playing ability ($r = .34$), it did not enter into the regression equation. The magnitude of this coefficient indicates that successful backs tend to be adventurous; however, there is a significant correlation ($r = .64, p < .005$) between this variable and the aggression variable which was included in the regression equation. Also, this variable correlated .22 with football-receiving ability and .26 with anaerobic power; while these are not significant intercorrelations, all of these facts could lead to the covariation explanation given above. Since adventurousness correlates relatively highly with three variables already included in the model, the amount of variance with the criterion left over after being factor-ed out of the three variables included in the regression model conceivably could be quite small.
Finally, the trait of tenseness did not enter the regression equation. Cattell et al. (1974), in *The Handbook for the Sixteen Personality Factor Questionnaire* state that this factor is best described as a function of general frustration. It can be seen by the nonsignificant correlation with the criterion (−.01) that this trait is evenly distributed among the football tryouts in this study.

One of the major difficulties with this research is the relatively small number of subjects included. Prior to the first summer tryout session, the coaches expected between 40 and 60 people to vie for this position. During actual testing, only 22 people tried out for this position—three of whom were dropped from the analysis due to an insufficient number of completed subtest scores. In light of the small subject number, results should be viewed tentatively. Also, a cross validation of this study is necessary.

Another criticism of this study was the lack of adequate time to test for all of the variables. It was initially hypothesized that the ability to withstand pain would be an attribute that would correlate with success in this position. A subtest was devised, based on the method described by Ryan and Kovacic (1966) to measure pain tolerance. It was believed that the ability to
withstand pain is crucial to the offensive backfield position since these players tend to be the smallest and lightest on the team, while being constantly hit and tackled by players much larger and heavier than themselves. Therefore, an increased ability to withstand pain should correlate with increased football-playing ability. However, time limitations necessitated the elimination of this subtest. In addition, halfbacks frequently perform blocking tasks, and a simulation test devised to measure this skill was not implemented due to the limited amount of time available. Also, aerobic capacity was measured, but due to the small sample size and the resulting confounding effects, was not included in the analysis. Several psychological variables were also eliminated (group dependency and enthusiasm) due to the small sample size.

The results of this study indicate the need for future research in athletic prediction. Relative to this is the need for improved sample sizes and improved job analyses to delineate those aspects of a specific position that are important in determining success.

By using a test battery that has predictive power in selecting superior athletes, coaches could improve the quality of their team personnel over the typical subjective selection system that is currently used. This could result in improved team performance, increased profits,
prestige, improved psychological conditions, and improved general team effectiveness. Also, this test battery could be used to assess the relative skills of current team members in order to determine weaknesses in particular traits measured. Thus, a coach could spend more time training a player in areas of relative skill deficiencies instead of spending time on areas in which he is particularly strong. This can lead to an overall improved and consistent athlete, with concomitants similar to the above mentioned improved selection system.
APPENDIX A

Information and Consent Forms
Appendix A

Participation in Psychobiological Testing

As part of a Master's thesis, measures of psychological, physiological, and motor-perceptual traits and abilities will be obtained in the tryouts for the half-back position for the UCF football team. This research is an attempt to devise a set of tests that can be used to discriminate between potentially successful and unsuccessful halfbacks. If tests such as these could be developed to predict football-playing ability, countless time could be saved in the preseason tryouts. Your support and participation in this endeavor is greatly appreciated.

1. Psychological tests will be used to obtain personality measures of those people trying out for the halfback position. This information will be used to determine if there is a particular personality type that is successful in this position. This information will be obtained by the Cattell 16PF test. The information obtained by this test will be used only for the purposes of this research project and will not be made available to anyone not involved in this study.

2. A test designed to measure the willingness to tolerate discomfort will also be given. A stimulus will be presented to the leg that increases in discomfort until you signal the experimenter to stop, at which time the stimulus will be removed. You can stop this experiment at any time you wish.
3. The physiological variables measured will be a measure of cardiovascular fitness, measured by stepping up and down on a stool for a short period of time, and a measure of short-term energy, measured by having you run up a flight of stairs.

4. Motor and perceptual skills (specific football-playing skills) will also be measured. The following tests will be given: running speed (10 yards), blocking ability, pass-receiving ability, and perceptual and motor speed.

You will retain the right to withdraw from the experiment at any time, without penalty, punishment, or derogatory consideration from either the experimenter or the football coaching staff.
CONSENT

1. It is hereby acknowledged that the psychobiological testing described above is for the purpose of research only, and will not be used in the selection and retention of football players; therefore, by participating in this testing, I am not jeopardizing my status on the football team.

2. I hereby give permission to administer the psychobiological tests described above.

3. I understand that some of the tests will be stressful.

4. I hereby release the experimenter, coaching staff, athletic department, psychology department, and the University from responsibility due to accidents occurring during testing.

5. I realize that I may withdraw from testing at any time that I so desire.

__________________________________________  ___________________  ___________________
Signature                        Age                  Date signed

__________________________________________  ___________________
Experimenter's signature                  Date signed
APPENDIX B

Skill Importance Chart for the
Offensive Backfield Position
## Skill Importance Chart for the Offensive Backfield Position

### Rater: ________________________

<table>
<thead>
<tr>
<th>Skills</th>
<th>(5)</th>
<th>(4)</th>
<th>(3)</th>
<th>(2)</th>
<th>(1)</th>
<th>assigned weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAMINA - (the ability to endure long periods of hard work without tiring)</td>
<td>must have this skill</td>
<td>this skill should be highly developed in order to be successful</td>
<td>this skill is important but not absolutely necessary</td>
<td>this skill is important; could still be developed in order to be successful</td>
<td>this skill is unimportant and not needed to be successful</td>
<td>4.33</td>
</tr>
<tr>
<td>RESPONSIVENESS TO CHANGE IN DEFENSE (the ability to perceive the location of the defensive players &amp; act accordingly, whether during blocking, pass-receiving, or rushing)</td>
<td>OVERALL SPEED (the ability to run quickly when needed)</td>
<td>BLOCKING ABILITY (the ability to consistently provide blocking protection for the ball-carrier)</td>
<td>4.00</td>
<td>4.00</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td>Skills</td>
<td>(5)</td>
<td>(4)</td>
<td>(3)</td>
<td>(2)</td>
<td>(1)</td>
<td>assigned weights</td>
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</tr>
<tr>
<td>GENERAL PASS-RECEIVING ABILITY (the ability to be in position and hold on to the football when passed to)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.67</td>
</tr>
<tr>
<td>ABILITY TO CATCH BALL IN TRAFFIC (the ability to catch and hold on to the ball when surrounded by defenders and/or when hit at the same time)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.00</td>
</tr>
<tr>
<td>GENERAL BALL-HANDLING ABILITY (the ability to hold onto the football when running through the line without dropping it when hit)</td>
<td></td>
<td></td>
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<td></td>
<td>4.67</td>
</tr>
<tr>
<td>RUSHING ABILITY (the ability to find &quot;holes&quot; in the line and anticipate the right moves, fakes, and changes in speed necessary to successfully avoid being tackled)</td>
<td></td>
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<td></td>
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<td></td>
<td>5.00</td>
</tr>
</tbody>
</table>
### Skill Importance Chart (cont.)

<table>
<thead>
<tr>
<th>Skills</th>
<th>(5)</th>
<th>(4)</th>
<th>(3)</th>
<th>(2)</th>
<th>(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BALANCE IN RUNNING (the ability to stay on one's feet while changing directions, faking, and being hit by the defense)</td>
<td></td>
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<tr>
<td>ABILITY TO FAKE BALL CARRYING (the ability to deceive the defense into thinking that he is carrying the football during a fake handoff)</td>
<td></td>
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<td></td>
<td>4.33</td>
</tr>
<tr>
<td>HANDOFF TIMING (ability to successfully carry out a handoff smoothly, without dropping the ball or &quot;bobbling&quot; it)</td>
<td></td>
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<td>3.00</td>
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<tr>
<td>ABILITY TO FOLLOW PLAYS (the ability to carry out his function in each play successfully)</td>
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<td></td>
<td>5.00</td>
</tr>
<tr>
<td>COOPERATION WITH TEAMMATES (the ability to work and get along with fellow teammates)</td>
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<td></td>
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<td></td>
<td>4.00</td>
</tr>
<tr>
<td>Skills</td>
<td>(5)</td>
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<tr>
<td>must have this skill highly developed in order to be successful</td>
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</tr>
<tr>
<td>this skill should be well developed in order to be successful, although not absolutely necessary</td>
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</tr>
<tr>
<td>this skill is important but does not need to be highly developed in order to be successful</td>
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</tr>
<tr>
<td>this skill is unimportant; could still be successful with minimal development of this skill</td>
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<tr>
<td>this skill is unimportant and not needed to be successful</td>
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</tr>
<tr>
<td>OVERALL ENTHUSIASM (the amount of overall desire, eagerness, and interest that the player displays)</td>
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<tr>
<td>WILLINGNESS TO WORK HARD (the amount of motivation, effort, and work that the player is willing to provide)</td>
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</tbody>
</table>
APPENDIX C

Football Ability Evaluation Chart
## Football Ability Evaluation Chart

<table>
<thead>
<tr>
<th>Skill</th>
<th>Excellent</th>
<th>Good</th>
<th>Average</th>
<th>Below average</th>
<th>Poor</th>
<th>Not able to rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STAMINA</strong> - (the ability to endure long periods of hard work without tiring)</td>
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<td><strong>RESPONSIVENESS TO CHANGE IN DEFENSE</strong> (the ability to perceive the location of the defensive players &amp; act accordingly, whether during blocking, pass-receiving, or rushing)</td>
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<tr>
<td><strong>OVERALL SPEED</strong> (the ability to run quickly when needed)</td>
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<tr>
<td><strong>BLOCKING ABILITY</strong> (the ability to consistently provide blocking protection for the ball-carrier)</td>
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</tr>
<tr>
<td><strong>GENERAL PASS-RECEIVING ABILITY</strong> (the ability to be in position and hold on to the football when passed to)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skill</td>
<td>Excellent</td>
<td>Good</td>
<td>Average</td>
<td>Below average</td>
<td>Poor</td>
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<tr>
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<tr>
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<td>(the ability to find &quot;holes&quot; in the line and anticipate the right moves, fakes, and changes in speed necessary to successfully avoid being tackled)</td>
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<td>(the ability to stay on one's feet while changing directions, faking, and being hit by the defense)</td>
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Reference Notes


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