THE APPLICATION OF DISCRIMINANT ANALYSIS AND LOGISTICAL REGRESSION AS METHODS OF COMPILATION IN THE PREDICTION FUNCTION IN YOUTH RUGBY

by

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SUMMARY

TITLE: The application of discriminant analysis and logistical regression as methods of compilation in the prediction function in youth rugby.

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Talent identification is a process where potential sportsmen/women are identified and developed in a specific type of sport. One of the primary reasons for talent identification is to ensure the future survival and development of the particular sport in which the talent is identified and sought.

Another very important reason for talent identification is to be of assistance to the individuals who are being tested for talent. Should these individuals possess talent, they can be further developed. Should they not possess talent for a particular sports-type, they can be redirected in responsible and sensitive manner

Worldwide there is a move toward the identification of talent, with certain countries ahead in the process, successfully applying it to their national sporting codes. Due to our exclusion from international competition for many decades, we find ourselves in the position of being behind in the field of talent identification, albeit catching up very fast.

What has been noticed however, is the move towards the favoring of two primary methods of talent identification, namely discriminant analysis and logistical regression. Different countries of the world use either of these methods, with an open debate currently being fought as to the predictive abilities of these respective methods.

This study compares the two main models of talent identification i.e.: discriminant analysis and logistical regression in terms of their ability to predict talent and their prediction functions, hopefully assisting in resolving the debate as to which is the better model and why.

These models were applied to two U/12 groups of rugby players. One group was talented, the other less so. The results were compared and then certain conclusions and recommendations were made about these models.

A literature study was also done to give this study a philosophical foundation. This included evaluations of other models, the development of these models in history, as well as discussions on whether talent identification is needed or not.

Honest discussions about the advantages, disadvantages and options of combining the two models as well as recommendations for future applications are also contained in this study. The hypothesis is made that there is a significant difference in the predictive function of the one model with relation to the other. This hypothesis has proved to be inaccurate, with the predictive function found to be exactly the same in both models.

Other questions were asked and answered by this study. With the hypothesis being disproved, some of the questions were found to be irrelevant and there was no need to evaluate them further. One question that is investigated and evaluated is whether it is possible to combine these two models to form a more accurate model.

Through various methods of statistical evaluation and substitutions, it is found that by combining the two models a less accurate predictor is formulated, negating the need to combine the two models. This then elicited the conclusion that each model, whilst both being 100% accurate, could be applied under different circumstances when different information is sought.

Discriminant analysis provides an accurate view of the best discriminating factors involved in talent, while logistical regression provides a view of the relative impact of the various factors that determine talent. As can be seen, both of these models can and should be used effectively in the identification of talent.

The proposition is made that when talent is identified, both models be used rather than following an "either-or" approach. The advantage with this is that a well-rounded view of the individuals under scrutiny after applying both models is formulated. Therefore, in summary it can be said that both models predict with the same accuracy, with each model having it's own unique areas of application.

Keywords: Talent
Identification
National sporting codes
Rugby
Methods of compilation
Prediction function
Logistical regression
Discriminant analysis
Discriminating factors
Relative impact

OPSOMMING

TITLE:	Die toepassing van diskriminante analise en logistiese regressie as metodes van samestelling in die voorspellingsfunksie in jeug rugby.
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Talentidentifisering is 'n proses waardeur potensiële sportlui geïdentifiseer en ontwikkel word in 'n spesifieke sportsoort. Een van die primêre redes vir talent identifikasie is om die toekomstige oorlewing en ontwikkeling van die sportsoort waarin talent geïdentifiseer en gesoek word, te verseker.

'n Ander baie belangrike rede vir talentidentifikasie is om van hulp te wees vir die individu wat getoets word vir talent. Sou die individu oor die nodige talent beskik, kan hulle verder ontwikkel word. Sou die individu nie oor die nodige talent beskik vir 'n sekere sportsoort nie, kan hulle in 'n verantwoordelike en sensitiewe manier begelei word in 'n rigting waarin hulle heelwaarskynlik sou presteer.

Wêreldwyd is daar 'n neiging na die identifikasie van talent, met sekere lande wat ver voor is in die proses, waar hulle dit suksesvol op hulle nasionale sportkodes toepas. As gevolg van die uitsluiting uit internasionale deelname vir etlike dekades, bevind Suid Afrika hom in die posisie waar hy agter is op die gebied van talentidentifikasie, alhoewel daar baie vinnig vordering gemaak word.

Wat baie duidelik is, is die neiging na die voorkeur van twee primêre metodes van talentidentifikasie, naamlik diskriminante analise en logistiese regressie. Verskillende lande in die wêreld gebruik of die een metode of die ander, waar daar huidiglik 'n ope debat is oor die voorspellings vermoë van die twee metodes.

Hierdie studie vergelyk die twee hoof modelle vir talentidentifikasie, naamlik diskriminante analise en logistiese regressie in terme van hulle vermoë om talent te identifiseer en hulle voorspellings funksies

Hierdie modelle was toegepas op twee O/12 rugby groepe. Een groep was talentvol, en die ander een minder talentvol. Die resultate was vergelyk en dan was sekere gevolgtrekkinge en aanbevelings gemaak oor die twee modelle.

Die literatuur was ook bestudeer om hierdie studie 'n filosofiese grondslag te gee. Hierdie het evaluerings van ander modelle, die ontwikkeling van die modelle in die geskiedenis en 'n bespreking oor of talentidentifikasie nodig is al dan nie, ingesluit.

Eerlike besprekings oor die voordele, nadele en die opsie van 'n kombinasie van die twee modelle sowel as aanbevelings vir toekomstige aanwendings is ook ingesluit. Die hipotese is geformuleer dat daar 'n beduidende verskil is in voorspellingsfunksie van die een model t.o.v. die ander model. Die hipotese is bewys om onakuraat te wees, met die voorspellingsfunksie wat dieselfde is vir albei modelle

Verskeie vrae is gevra en beantwoord in die studie. Met die hipotese wat bewys is om onakkuraat of onwaar te wees, is van die vrae bevind om irrelevant te wees en is dit nie verder geevalueer nie. Een vraag wat ondersoek en geevalueer is, is of dit moontlik is om die twee modelle te kombineer om 'n meer akkurate model saam te stel.

Deur verskeie metodes van statistiese evaluasie en vervangings, is dit gevind dat deur die twee modelle te kombineer, 'n meer onakkurate voorspeller geformuleer is. Die konklusie is gemaak dat elke model 100% akkuraat is, en dat die modelle onder verskillende omstandighede toegepas kan word wanneer verskillende soorte inligting gesoek is.

Diskriminante analise voorsien 'n akkurate oorsig oor die faktore wat die beste diskrimineer (diskriminerende faktore) t.o.v. talent, terwyl logistiese regressie 'n oorsig voorsien van die relatiewe impak van die verskillende faktore wat talent bepaal. Soos gesien kan word, kan en moet altwee die modelle effektief gebruik word om talent te identifiseer.

Die voorstel is gemaak dat wanneer talent geïdentifiseer word, albei modelle gebruik word, instede van 'n "of die een or die ander" benadering. Die voordel hiervan is dat jy 'n volledige heelbeeld van die individu wat onder fokus is, kry. In opsomming kan dit gesê word dat albei modelle met dieselfde akkuraatheid talent voorspel, met elke model wat oor sy eie toepassingsgebied beskik.

Sleutel Terme:
Talent
Identifikasie
Nasional sportkodes
Rugby
Metodes van samestelling
Voorspellingsfunksie
Logistiese regressie
Diskriminante analise
Diskriminerende faktore
Relatiewe impak

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CHAPTER ONE

RESEARCH PROBLEM AND GOAL OF STUDY

1.1) INTRODUCTION

Sport forms an integral and important part of today's society, not only in South Africa, but the world at large. Not only is it a physical outlet for the masses of participants who practice it for a variety of reasons and motivations, but also an emotional outlet for the even larger numbers of people who prefer to partake in the spectacle of sport from the comforts of their own homes, the so-called "arm-chair specialists."

Countries and individuals now base their level of pride on the achievement of their sports men and women, so much so that sport has become a multi-billion dollar industry worldwide. Where in the past, wars of conquest occurred on the battlefields that we now preserve as monuments to the days of old, in the modern era these very self same wars of conquest are fought on the sports field and mass arenas, albeit with much less risk to human life or loss of property.

It is only understandable then that to make success in sport a sustainable issue, identification of potential and talent should come to the fore and play a major role in today's sport environment. This talent identification is of such a nature that it is carried out on the young participants of sports, to facilitate the identification of the talented individuals and to nurture their talent to their fullest potential.

It must be remembered that adults are not the only sports enthusiasts. Sport forms an integral part of modern society and has a major influence on young developing children (Blansky et al., 1994). Where the ideal would be for children to partake in sport for the play element thereof, it has become increasingly clear by the very nature of sport that it is competitive and outcomes based. The norm for older sports participants is now also the norm for younger sports participants.

When youngsters partake in sports we have to deal with various issues that they may face as individuals. To avoid disappointment and subsequent disinterest in sport all together, it seems that the responsible thing to do would be to identify the individual's level of talent in the particular sports type that they may be partaking in. The advantage of talent identification in sport is that young participants can be canalised to sports types to which they are physically and psychologically best suited (Hare, 1999). The result is that good results are achieved and that the pleasure of exercise and participation are present (Bloomfield et al., 1994).

When a look is taken at the potential advantages this holds for the countries where these youngsters live, the extensive work carried out and the results obtained by the former East Bloc countries can be evaluated. The former East Bloc countries have delivered very good results in the sports arena in the past two decades, because they bestowed a high priority on the identification of young children with specific talent and potential (Du Randt & Headley, 1993).

These countries, such as the former Union of the Soviet Socialist Republic, the German Democratic Republic and the Republic of China, have to their disposal well thought out and effectively applied talent identification techniques (Hare, 1999). The structured systems that are followed by these countries facilitate the smooth progress of the process and possibly promote the good results achieved at the Olympic Games and world competitions (Hare, 1999).

It stands to reason then, that these countries perfected certain methods that they used successfully, effectively and accurately to predict talent in the selected individuals. One merely needs to look at their results. This poses an interesting question, and one that will be examined in more detail later: will other countries be able to successfully apply these methods in their own context of sport? Will they be able to take predictions with the same level of success, in different sports types?

Some Western countries were initially sceptical about the methods used and the results obtained (Spamer, 1999). Such was the level of scepticism that two decades ago the Canadian sport scientists gave research on sports talent identification the lowest priority. It appears as if the Western countries only realized the value of talent identification recently, and started to develop programs of their own. Although there seems to be a slight disadvantage in terms of their programs being not as systematic and scientifically developed as the East Bloc, they are definitely making major strides and improving on them.

When the South African scenario is evaluated, it can be seen that we are well behind when it comes to the arena of talent identification. Up and till a few years ago, talent identification in South Africa received very little attention. Certain studies were done in the field of athletics and gymnastics, but it can be fair to say that South Africa's re-admittance to the international sports arena provided us with new insights and challenges regarding international sports participation. Du Randt (1993) made a major contribution to research in South Africa through her perspective regarding talent identification on a national and international basis. This will however be discussed in greater detail in chapter 2 of this study.

Pienaar & Spamer (1996) and Pienaar et al. (1998) also made numerous positive contributions to the field of rugby during the 1990's, especially in the field of identifying talented young rugby players. Other examples include studies done by Pretorius (1996), Van der Merwe (1997) and Hare (1997, 1999). The truth remains however, that more research needs to be done in this area, hence the need for this study.

1.2) STATEMENT OF PROBLEM

As noticed from the above, talent identification in sport is a wide field, which is relatively new to South Africa. As will be seen in later chapters, South Africa only entered into the field of talent identification at roughly the same time that we were aloud back into the international sporting arena. Therefore, it is only obvious that we are relative newcomers to this field.

In the past isolationist era only a certain sector of the population had the opportunity to practice sports in a structured formal kind of way, whereas the majority were discriminated against and not afforded the opportunity to partake in these structures. The result was that numerous sportsmen and women were denied privileges that allowed them to develop into talented and identified athletes. While it cannot be denied that the talent was there, it wasn't afforded the opportunity to flourish in a way that was beneficial to the individual or the country. What resulted was this talent either not being recognized, or being lost for good.

When allowed back into international competition, the lack of experience showed, even though we managed to perform respectably. The problem was that many of the sportsmen and women were experienced in domestic competition. That however, in many instances was not enough.

Further exacerbating the problem was the fact that those sportsmen and women who did participate in the first international encounters were nearing the end of their careers. There were young participants coming through the ranks, but not nearly enough to cover for the obvious vacuum that would be felt after the older athletes' departure from the international scene.

We are now currently at a very important juncture in this country's history, not only politically or economically, but also on the front of transformation that is affecting all aspects of life in South Africa. There is a concerted drive to correct the perceived (whether correctly perceived or not, depending on whether individuals benefited or were on the receiving end) injustices of the past.

This places everyone in a difficult, if not precarious position. While this study is not about politics, it is important to note that situations are encountered almost daily that are not always necessary or applicable. It would also be unwise to ignore the fact that in today's dispensation politics plays a major role at national, regional and provincial level, with the effect also gradually being felt at club level.

This is affecting South African sport in a very real way. While the minor sports don't seem to be receiving so much coverage regarding this, the major sporting codes are being affected in a very real way. Talent needs to be identified and transformation needs to be implemented. The question still remains: at what cost?

It is true and right that all South Africans need an equal chance in all sports types. It is also true that most South Africans feel a high level of passion and patriotism for this proud country of ours. We have a marvelous sporting history and record, and the ideal would be to continue in this, and set new records.

Standards need to be maintained as well as lifted to a higher level, as it would be defeating the purpose to drop the standard to a lower level so as to include everyone! It is therefore important that new and current research in the field of talent identification be commissioned and applied.

New avenues need to be examined in detail, and no proverbial rock should remain unturned. Therefore, other countries methods also need to be examined to see if they are onto something that may be more effective than what we currently have in this country. This study's aim, even in a small way, is to be able to contribute and assist in the above viewpoint, and in so doing add to the body of knowledge that already exists in this country.

An in depth study of the available literature was performed during the course of this study. Numerous researchers were referred to, researchers who set the trend that the rest can now follow and expand upon. When the literature is examined, it becomes apparent that there are two favored statistical methods that are used by researchers to distinguish between the talented participants and the less talented participants.

These two methods are the discriminant analysis (Salmela's Conceptual Model with Discriminant Analysis) and logistical regression (Chi's Model of Logistical Regression) methods (Salmela & Règnier, 1983). The former method is one that is more commonly in use in South Africa. While it has delivered valid and reliable results, it was deemed

necessary to evaluate it and compare it to other methods that are available, namely the latter method. This method is more commonly used in the Eastern countries, who also claim that it delivers valid and reliable results.

It is important therefore, that, as mentioned before, other countries' methods also be evaluated. The biggest mistake that a developing country like South Africa can make, is to think that we know it all and to adopt an attitude of not being able to be taught. We need to learn as much as we possibly can from other countries. We do not have to adopt their methods exactly, as that would be unwise. We can however, adapt them to suit our specific needs.

The question that arises in the mind of both the coach and the researcher is the following: do the two above-mentioned methods supply the same results regarding the development of predictions by which potentially talented participants can be identified?

Further questions can be asked:

- If there are differences in the result obtained by the two methods, are these differences significant?
- Can these differences in the findings of the two methods, if any, mean the difference between success and failure or the overlooking of a talented player in favor of a less talented player?
- Is there a way to combine these two methods to form a more accurate method?
- Could this study perhaps help South Africa in the current situation that we find ourselves regarding the identification of talent in the previously disadvantaged communities?

1.3) GOAL OF STUDY

The goal of this study is as follows:

The focus and goal of this study is to perform a statistical comparison between discriminant analysis and logistical regression regarding the development of prediction function by using existing data concerning 12 year-old rugby players. Discriminant analysis has been done on the sample group, with specific results obtained.

Logistical regression is then done on the same sample group to determine if the collective predictive functions differ in terms of talented and less talented players. Once the comparison has been performed, the results will be examined with the resulting discussion as to the benefits of the two methods, and the approach needed by coaches, researchers and sporting authorities in this country.

1.4) HYPOTHESIS

The goal and purpose of this study will be researched according to the following hypothesis:

1) There is a difference between the results obtained by the Discriminant Analysis method and the logistical regression method regarding the prediction of talent and the establishing of prediction functions.

1.5) METHODS

1.5.1) Literature study

A literature study was done primarily to give this study a theoretical framework from which to work, as well as a background to refer to. Terrains that were focussed on were talent identification in sport on a national as well as international level, as well as how these methods can be applied in the South African context.

This literature study can be seen in chapter 2.

Comparisons were made and discussed between methods on a theoretical level. Certain advantages and disadvantages of the methods were highlighted. The premise was made that as much background information as possible needs to be garnered to lay down the philosophical foundations for this study. No study can proceed without fully evaluating the background and reasoning behind the study, and in so doing fully taking into account all the factors involved.

1.5.2) Empirical investigation

1.5.2.1) Design

Phase 1: This phase consisted out of the identification and compilation of talented sample groups. There are 2 sample groups namely the S.A. Nike Elite u/12 group (N=43) (now referred to as the NE, or SARFU group) and the North West u/12 group (N=40) (now referred to as the NW, or MSP group). The phase was completed in the following way:

The talented individuals were identified by means of the fact that the NW group was part of the team that was selected to play for the province of North West at the Craven Week for primary schools in their age group. The NE group were identified by means of the fact that they were selected to attend the S.A. Nike Elite training camp to be held at a specified time. This group represents the best potentially talented u/12 group of rugby players in South Africa.

Phase 2: This phase consists out of the evaluation of the talented players according to a battery of tests set up specifically for them. They were tested on the following days: The NE group was tested on 17/02/99 and the NW group were tested on 03/04/99. During the evaluations, the same test battery was used for both groups.

1.5.2.2) Measuring instruments

Numerous batteries of tests have been described in the literature whereby talented youngsters can be identified for further developmental programs. Pienaar & Spamer (1995, 1996) have done numerous studies in the past few years with the aim of compiling a battery of tests whereby talented 11 year old rugby players can be identified for further developmental programs (Hare, 1999). The battery of tests that was followed for the monitoring of the progression of rugby players was the same as the one used by Pienaar & Spamer (1996), with certain additions (Hare, 1999).

The original rugby skills tests were added, namely passing for distance, passing for accuracy over 4m and 7m, running and catching, kicking for distance and kick-off for distance, as used by Pienaar & Spamer (1996) and by Hare (1999). Extra tests such as throw and catch (Miller 1989) and pick up ball (ARFU, 1990) were considered, but ultimately not included.

The motor/physical abilities tests, namely sprint time/speed, agility run, flexed arm hang, vertical jump and speed endurance correlated with the tests used by Pienaar & Spamer (1995) that were done on 10 year old players, and Hare (1999). Hare (1999) performed 18 anthropometrical tests, as proposed by the Society for the Advancement of Kinanthropometry (Eston & Reilly, 1996).

These tests were evaluated, and a selection of these was included in the test battery. For a full description of these tests as well as the previously mentioned tests constituting the test battery, refer to Table 1. As stated before, two groups were identified and tested. They were the S.A. Nike Elite u/12 group (N=43) and the North West u/12 group (N=40).

Table 1) Battery of tests that were used in the study

Anthropometrical Tests	Motor/Physical Tests	Rugby Skills Tests
Body Mass (kg)	Speed (s)	Passing for Distance (m)
Triceps SF (mm)	Agility Run (s)	Passing for Accuracy-7m (score)
Subscapular SF (mm)	Flexed Armhang (s)	Passing for Accuracy-4m (score)
Supraspinal SF (mm)	Vertical Jump (cm)	Running and Catching (n)
Medial Calf SF (mm)	Speed Endurance (% decrease)	Kick for Distance (m)
Upper Arm Girth (cm)		Kick-off for Distance (m)
Calf Girth (cm)		
Humerus Breadth (cm)		
Femur Breadth (cm)		

1.5.2.3) Data analysis/assimilation

The athletes were subjected to the battery of tests as shown above. The data was then analysed according to the discriminant analysis method with certain results obtained, where after logistical regression was done to obtain another set of results. The results were then compared according to the respective predictions of both methods. The results of the tests prove to be conclusive, with the results examined in chapter four and discussed in chapter five.

CHAPTER TWO

REVIEW OF RELATED LITERATURE AND STATISTICAL METHODS

2.1) INTRODUCTION

In this chapter a more in depth look will be taken into firstly the concept of talent identification and how it developed over the years, and then secondly the different methods that are used, and thirdly and finally the two methods that are of interest to this study.

It is important however, that we first take a look at a few terms that will be referred to in the course of this study. According to the definition that Du Randt (1993) supplies, it can be seen that ***talent*** can be defined as *"... the aptitude manifesting itself in a certain direction, exceeding an average standard and being not yet fully developed"* (Pretorius, 1996). According to Blooms (1985) talent is defined as an *"unusually high level of demonstrated ability, achievement or skill in some special field of study or interest..."* (Myburgh, 1998).

One merely needs to read an excerpt out of Brown (2001) to see that talent related to sport is a slightly more vague term. He states that *"If sports talent is that desirable and that important, what exactly is it?"* He then goes on to quote two dictionary definitions that define talent as *"a special, natural ability"* and *"a capacity for achievement or success,"* stating that his problem with these definitions is that they do not define talent as it relates to sport (Brown, 2001).

According to Brown (2001), when he researched the dictionary for the definitions of the concept of an athlete, he found that *Webster* described an athlete as *"a trained competitor in a sport."* An athletic person, however, is merely *"physically active and strong."* According to Blooms (1985) the conclusion is made that what any person in the world can learn, almost all people can learn-if provided with the appropriate prior and current conditions of learning.

However, there are approximately one or two percent of individuals who seem to learn in such unusually capable ways, that they are the exception to the apparent rule (Myburgh, 1998). Therefore, when the term talent is used in this study, it can safely assumed that it is that ability, be it in whichever field or practice, that is (far) above the normal or average, that which stands out and makes a powerful statement about the possessor's ability in their chosen arena.

Myburgh (1998), in her study on the identification and development of swimming talent, refers to the concept of ***identification*** as *..."being used synonymously with selection, and concerns the act, process or method whereby those characteristics which have been identified as components of swimming talent are observed and recorded in a objective, measured and recorded in an objective and verifiable manner"*

For the purposes of this study then, we can take the above definition and apply it to the field of rugby, completing the statement as follows: identification concerns the act ... whereby those characteristics which have been identified as components of rugby talent are observed, measured and recorded in an objective and verifiable manner.

When combining the above two terms, it can seen that ***talent identification*** according to Woodman (1985) involves *"...the screening of young athletes to determine those most likely to succeed in sport and directing them towards the sports for which they are most suited."*

When taking all the above definitions into account, talent identification can be defined as: identifying those individuals who posses a quality of execution or ability to perform, that is (far) above the normal or average, that stands out and makes a powerful statement about the individual's ability, with the intention of future development and nurturing of this talent, to the benefit of the individual as well as the country.

Before a further look at the literature regarding talent identification is taken, perhaps the following question should be answered: why test or identify talent?

According to Bosco & Gustafson (1983) *"... the reasons for testing can be divided into nine discrete categories: 1) classification of students; 2) diagnosis of student needs and weaknesses; 3) evaluation of instruction; 4) evaluation of program; 5) marking; 6) motivation; 7) instruction; 8) prediction and 9) research."*

The above is interesting, when relating it to the athlete or sports participant. We see that there are numerous advantages such as classification and diagnosis of needs and weaknesses and even motivation. What is interesting is that Bosco & Gustafson (1983) are of the opinion that testing plays an important role in prediction and research. Although the above reasons for testing seem to be predominantly advantageous, certain arguments for and against talent identification and prediction will be discussed in more detail later in this chapter.

In the context of the South African scenario, it needs to be remembered that due to the fact that South Africa was isolated from world sport for more than two decades, this state of affairs almost certainly led to South Africa getting left behind in the field of scientific methods used to identify talent. Talent identification was predominantly based on results from competition and the subjective judgement of coaches. A few sports do actually practice talent identification and development, but even here most of the methods are unscientific, with sporadic attention being paid to this concern (Van der Merwe, 1997).

It is therefore painfully clear that this is far from the ideal. It simply is not enough to follow unscientific methods and expect to perform well and remain competitive. Traditionally South Africans have had a competitive nature, where winning is the only result that matters. This in itself is not a problem, until we compete against a country with the same attitude, but with more advanced methods.

In South Africa, due to the pleasant climate indigenous to our country, sport plays a major role not only in terms of participation, even on an informal level, but also on a supporters level, where certain sports types enjoy an almost religious like following.

One of the sports types that has a large and committed following is rugby, a sport in which we have a particularly proud history and ability. Upon investigation of the literature to evaluate the type of research that has been done in the area of rugby, we see that scientific methods have been primarily used to formulate fitness programs and profiles (Hazeldine & McNab, 1991; Turnbull et al., 1995).

These fitness profiles were used to categorize players as talented or less talented. When entering the terrain of talent identification involving youth rugby players it is found that scientific identification was, until recently, relatively unknown (Hare, 1999). According to Hare (1999) however, in recent times researchers (Pienaar & Spamer, 1995; Pretorius, 1996; Hare, 1997; Van der Merwe, 1997) have compiled scientific test batteries according to which youth rugby players can be identified for further development.

The purpose of this study is to assist in the above, i.e.: to expand or broaden the base in South Africa whereby testing and research regarding talent identification in South Africa can be done. The reason why this study can be of particular value is due to the fact that it is comparing two methods or methods of talent identification that are commonly in use. The question is always present, namely, does one method of talent identification work better than the other method? In this study, that question will be addressed and hopefully answered.

2.2) BACKGROUND

For the latter part of the 20th century (and for the humble beginnings of the 21st century) it has become very clear that research into the field of talent identification has increased, with more and more researchers focussing on this terrain. Firstly, a general survey of talent identification worldwide will be presented, and secondly a discussion regarding the specific methods for talent identification in sport will be considered, where their relative advantages and disadvantages will be reviewed.

From the discussion of these methods, the conceptual model of Régnier (1987), which was used as framework for this study, will be evaluated. The relative functions of this method will be critically evaluated and there will also be indicated where this method conforms to the requirements of this study.

When the literature regarding this subject is reviewed, one finds various and varying points of views and ideas. Not all people agree to the need or function of talent identification. There are those who are in support of this practice. Singer *et al.* (1993) are of the opinion that all methods of talent identification eventually aim to predict future achievements of sportspersons, based on present abilities. Heilbrun (1966) supports the above point of view, namely that *"talent identification actually evaluates that which exists in actuality, not in possibility."*

As mentioned earlier, you also find the detractors of this practice, with talent identification at a young age receiving much criticism. The general consensus is that talent identification at a young age is not necessary, and can even be counter productive. Some researchers are of the opinion that a young sportsperson does not always reveal or possess all the variables that are necessary for later optimal achievement (Spamer, 1999).

Another author, Jim Brown, while not fully a detractor himself, quotes those in his book, *Sports Talent: How to Identify and Develop Outstanding Athletes,* who are sceptical of the process. Brown (2001) quotes Robert Singer, when he states that *"Everybody wants to predict athletic success based on present achievement or physical makeup…but predicting success is much more difficult than most people think. There are too many variables, even if certain athletes have a combination of genes that favours long-range talent".*

Singer et al. (1993) then goes on to say *"A person's genetic makeup can be expressed in many different ways, depending on environmental and situational opportunities. Variables such as motivation, coachability and opportunity can't be predicted.*

If one wants to say that you are much more favoured than I am to be a world-class champion due to genetic composition at birth, I can't argue the point. You can determine that one eight-year-old gymnast is more advanced than another but to project that talent 10 years forward and say that the child will be a world-class athlete is impossible" (Brown, 2001). Singer makes his point based on genetic factors versus so-called environmental, maturation or even psychosocial variables. This point is discussed at a later juncture in this chapter.

According to Spamer (1999), it is quite possible that, due to the processes involved in talent identification, potential top achievers may be disadvantaged or even eliminated as a result of slow growth, ripening, and development. Many coaches and sport administrators are of the opinion that all young talent should be accommodated and assisted to maturation, rather than to eliminate a number of the less talented.

As stated in the introduction, the play element should be encouraged and incorporated, and in so doing leave a good experience regarding sport, rather than one that is negative. Accommodation and the responsible accompaniment of youngsters has the advantage that children who do not possess sufficient talent, can be diverted to other fields in an ethical and educationally responsible way.

What must be remembered, this being a point supported by certain researchers, is that in no way may anyone remove the freedom of choice from a child to partake in a sport that the child may choose to partake in. These researchers are of the opinion that the implementation of talent identification programs may do just that.

The flip side of the coin however, is that talent identification has numerous supporters. Talent identification at a young age is supported by the literature studied, as it also holds certain advantages. The talented child receives the correct coaching, and this has economic advantages for the parents and for the country concerned. This fact can be argued that this is highly beneficial.

Not only is the child then coached in the area that he or she likes best and has a higher aptitude for, but they are also coached correctly, with the likelihood of that child achieving success in the direction that they have chosen.

Children are also referred to types of sport for which they show the best aptitude physically and psychologically. This can once again be seen as beneficial because of the time aspect involved. Time is not wasted following an arbitrary "hit and miss" approach, with all the efforts being focussed on that which the child is talented in, with the likelihood of success being very high.

Woodman (1985) echoes this statement by implicating that *"...This leads to good results being obtained and in the pleasure of exercising and participation in general being experienced."* The search for potential champions at an early age is therefore becoming an increasing practice in high performance in sport, especially if it is generally accepted that young players want to achieve success in specific types of sport (Hare, 1999).

Early identification of talent may also result in a better performance, as techniques which developed in young, talented sportspersons at an early age, will enable them to reach a higher performance level by the time when they participate in high-level competitions (Woodman, 1985). The question also begs to be asked: could this lead to them reaching high-level competition at a younger age? The possibility is that unidentified talent, or those who are identified at a later stage take a longer time to reach the high level they aspire to.

Therefore, the added advantage is that the talented youngster who is identified at an earlier stage may reach high-level sport sooner, with the benefits, be they economic or otherwise, glaringly obvious. The responsibility of the administrators or the coaches will then also lie with channelling the youngster in the right direction and preventing the burnout associated with extended participation in competition, especially at a young age.

It has been found that talent identification at an early age also has several disadvantages. It has been reported that between 22% and 35% of children between the ages of thirteen and fifteen years do not participate in sport any longer (Hare, 1999). It has been stated by St-Aubin & Sidney (1996) that they are of the opinion that a possible reason for this may be that participants feel that they are no longer competitive enough to successfully participate in sports.

There are probably many reasons for this, least of which being that after being classified into the talented or less talented category, that they may feel the extra pressure of the classification in the former (talented) category, feeling that they need to perform at a top level constantly, having to follow a results based approach based on success. This could lead to exhaustion and remove the fun or enjoyment element from the game.

The converse is true that if they find themselves classified in the latter category (less talented) they may wonder what the need is to continue competing, as the proverbial "numbers are against them." No one would be able to meaningfully compete in a sport that they love, knowing that they have been classified as less talented, and in so doing not been given a good enough chance of success.

Another possible problem is that the prediction functions are not always dependable, and that potential sportspersons do not always perform as expected, which means that talented children are lost for sport (Hare, 1999). Should this occur, it would be a tragic consequence. The search for more and more dependable predictive functions and models is ongoing, and is one of the primary motivators behind this study.

2.2.1) TALENT IDENTIFICATION - INBORN TALENT AND TRAINING

One of the most practical definitions for talent identification is that of Woodman (1985). According to him, talent identification is *"the screening of young athletes to determine those most likely to succeed in sport and directing them towards the sport to which they are most suited."*

Salmela & Régnier (1983) make a convincing argument when they say that one should distinguish between talent selection and talent detection in this regard. The difference between the two terms lies in the aspect of time. Talent selection has to do with a prediction of performance in the short term in accordance with the sportsperson's performance in light of certain variables at that stage.

In essence, you are choosing from what is available and present at the stage of selection. The possibility for misjudgements are higher, as we all know the factors that can play a role in the performance of an individual at a specific state in time.

Talent detection refers to prediction over a longer period where the sportsperson possesses the necessary talent and usually follows a development programme. It seems that talent detection is the more accurate of the two approaches, as it evaluates that which is present over a specific period, and takes differing circumstances into consideration.

It is clear therefore, that talent detection can be carried out on either a short-term or a long-term basis. Schneider (1993) garners support when he states that he is of the opinion that it is not only the identification process that is important, but that the success of the sports person also be determined by the development programme to be followed afterwards.

It is no use to identify talent that exists, and then not develop it to it's fullest potential. It is irresponsible to let talent that has been identified go to waste by not placing it in some kind of developmental program where the talented individual can eventually achieve the highest honour available to them.

An article in a prominent Sunday newspaper was published in which a prominent and respected Australian rugby union coach stated that South Africa would become the world's leading sporting and rugby nations the moment we identify our untapped potential. He stated however, that merely identifying potential means nothing unless it is developed properly. This sentiment is echoed around the world. If the rest of the world

can see this, then it is about time that South Africans realise this too.

Sufficient evidence abounds in various terrains in world sport that young people perform differently to one another. Howe et al. (1998) states that it is generally accepted that this difference can be attributed to the presence or absence of natural talent, abilities, and training. It is only natural that certain youngsters have more access to training facilities and methods than others. And some, we can assume, are more blessed with natural talent than others.

The question arises: what role does each of these factors play in the level of success that these youngsters achieve and to what extent? Another question that we can ask is what kind of influence do these factors have on one another?

Once again we find divided views on this. Some researchers are of the opinion that talent is hereditary and that it plays a role in performance, whereas others are of the opinion that training is the primary determinant of success (Hare, 1999).

Howe et al. (1998) are of the viewpoint that talent is important for performance in sport and that it comprises the following characteristics:

- Firstly, it originates from genetic structures and is partly inherited;
- The effect in performance is not so visible initially, but some of the early signs of talent are perceptible, and can be used by coaches;
- Because talent can be identified early, a basis can be formed in order to carry out identification scientifically or by means of observation;
- Only a small number of people possess this talent (Hare, 1999).

This is a divisive factor. The evidence that talent is genetic is obvious daily. One merely needs to look at the performances of talented youngsters, and invariably one will find a certain level of success in sport that was achieved by the youngster's parents.

On the other hand, however, one sometimes finds that certain children are successful in sport whether their parents were successful or not. One also needs to examine the environmental and social factors exerting their roles on the talented youngsters. Some were just more exposed to certain activities as youngsters than others.

Feldman (1988) agrees with the point-of-view that talent is inborn and cannot be acquired. Benbow & Lubinski (1993) support the principle that talent is inborn: *"talent is explicitly biological"*. Although there is support for the idea that talent is genetic, this is not necessarily a guarantee of achievement. It is also mentioned that children who have a specific talent, which is genetic, reveal this talent at an early age. Thus, in literature there is sufficient proof that talent has an inborn, genetic component that plays a definite role in achievement (Spamer, 1999).

Researchers such as Ericsson & Charness (1995) point out that no real predictions at an early age have yet been found to be a guarantee for later performance. They are of the opinion that success of performance in sport is primarily determined by training and exercise. They also profess that the specific hereditary, physiological character traits may positively benefit performance and achievement if these traits are of an extremely practical nature.

They used an example that is commonly found where certain athletes have predominantly slow contracting muscle fibres that are hereditary in nature. In the field we are dealing with, it is common knowledge that athletes with this kind of muscle fibre component are usually more suited to long distance running and endurance events. What has also been found however, as the above researchers found, that if you train for speed over short distances, that this will affect your achievements, as it did his, positively.

Therefore, according to Ericsson & Charness (1995), exercise is the primary determinant of success. The statements of researchers such as Elbert et al. (1995) and Schlaug et al., (1995) concur with Ericsson & Charness (1995), in which they *..."found that the changes that took place in the brain structure of talented players, should be*

ascribed to the effect of exercise and not so much to genetics".

As stated before, the standpoint needs to be taken that genetics combined with training and exercise need to be considered as primary determinants of talent in young children. The environments in which some children find themselves are of such a nature that they can play or practice freely and develop certain skills that may be apparent in other children, but less developed.

Therefore, due to the nature of the above, one cannot but concur that both factors, i.e.: genetics and exercise, play a very definite role in the identification and development of talent in the young child.

When the literature is further reviewed, further statements of great interest to the discussion of sports talent in youngsters are made. It is apparent that researchers are of the opinion that children can only be talented if they are still regarded as such over a long period of time. They go on further to say that an added requirement in this scenario is that these children should not have received any specialised training. Spamer (1999) goes on to say that extra or specialised training is to the advantage of the talented sportsperson.

Spamer (1999) refers to a longitudinal study done by Schneider (1993) on German tennis players in which it was found that achievement attained in the initial stages of participation is no guarantee for achievement at the early adult stage. This then proves that the duration of exercise or training that talented players are exposed to is also a determinant of success.

Where the researchers have a point when they state that a child can only be classified as talented should they still be talented years later with no extra or specialised training, it is not at all the best option to be followed. Raw talent is good, and may assist the individual in achieving initial success. Unfortunately, however, raw talent will not take you to the top.

In this day and age of specialised coaching and training techniques, those who are exposed to such training methods have an infinitely better advantage over those who do not have such exposure. It can be argued that it is irresponsible to not develop talented youngsters further, to assist them not only in improving on their natural talent, but also guiding them along the way towards sporting success.

When the findings of Sloboda & Howe (1991) are evaluated, another obvious factor in the discussion on sports talent is unearthed. These researchers emphasise the role that parents play in the development of talented sports persons. Sloboda & Howe (1991) made the point that parents have a role to play in their children's development of talent by the practice of ongoing encouragement and support. Howe et al. (1998) refer especially to the role of psychological aspects.

Spamer (1999) mentions the following determinants that play a part in the achievement of talented young sportspeople: attention and concentration, interest, motivation, self-confidence, personality and enthusiasm. It can be seen that the role that parents have to play in the above factors is great.

It must be remembered however, that parents are there to give constructive, positive support and guidance. All too often parents are found to be obsessive in their encouragement, to the point that they push their children to the limits of their endurance and abilities. This is not the desired outcome, and one that needs to be avoided at all costs.

Therefore, to sum up the divergent points of views on the topic of inborn talent, training and success in sport you find the following: it seems apparent that talent may have it's origins in genetic structures and heredity. This in itself however, is not enough. Practice and exercise are prerequisites for the development of these genetic structures and inherited talent.

Identification of these sports people is possible, and actually the ideal, as this can help to classify and develop these people. As stated on numerous occasions, identified talent needs to be nurtured if it is to reach it's potential, for the sake of the individual, firstly, the parents secondly and finally the country. National pride and the pride of the child is involved, something which cannot be taken lightly.

Unfortunately, the best things in life are rare, and hard to come by. It works the same way with sports talent. While there may be many who are capable, only a small handful are excellent. This needs to be remembered by those identifying and administering this talent. A final thought on this topic is that talent is sports specific, which means that it is related to specific sports types. Once again, this leaves those administering the sports the added advantage of taking good care of those identified as talented, if only for future success and competition.

What will follow now is a discussion of the various models that have been developed for talent identification in sport.

2.2.2) MODELS IN TALENT IDENTIFICATION

Before considering specific research models utilised for identifying talent, one should first analyse the methods by which the various models were composed. Singer et al. (1993) highlighted two approaches followed by researchers, namely the so-called devertical ("top down") approach and the evertical ("bottom-up") approach. The devertical method advocates the use of orthodox scientific methods (Spamer, 1999). Empirical data is gathered by using established scientific methods. Especially the methods which have been used by researchers (Singer et al., 1993).

Two methods of research are generally used by researchers (Singer et al., 1993). The first method is referred to as *single variable studies*. The disadvantage of this method is that only one variable is used in comparing achievers and non-achievers. In the field of talent identification, where numerous factors play a role and where you cannot merely focus on one factor, this method is highly limited.

The second method, namely *multi-variable studies*, eliminates the above problem found in single variable studies, as various variables are tested by means of statistical methods, and the underlying relationships between variables can be determined. This is a more realistic approach, and one where all the factors involved in talent identification can be exhaustively examined and even compared in terms of importance.

A well-known example of this type of study is where two experimental groups are selected, one group of which has performed well, and another group that has performed less well. The two groups are measured according to morphological, physical, and morphological, physical, and motor, psychological, and game-specific variables.

Consequently, in the above manner, variables are identified and utilized by means of which talented persons can be selected. In his report, Spamer (1999) mentions examples of such studies, which include the study done by Pienaar et al. (1998).

Later in this chapter, a more in-depth view of multi-variable models will be discussed, with particular reference to the two methods that are of interest to us in this study. As stated before, the two methods being compared in this study are the methods of logistical regression and discriminant analysis.

The so-called evertical approach aims to find out from top performers which aspects caused top performance and achievement. This is normally done by means of interviews, protocol analysis, and recall of achievements (questionnaire). Spamer (1999) states that *"according to this approach, top achievers are organized and structured categorically into problem or task types, most likely in a hierarchical or heterarchical perceptual and retrieval processing system, and on the basis of the particular goals and sub-goals each individual associates with those categories or types".*

Evaluating the knowledge base of the top performer or achiever is therefore an acceptable method to determine why some achieve success and others do not. According to Singer et al. (1993), the disadvantage of the evertical approach is that, as

soon as too many variables are analyzed simultaneously, the results may be questionable.

According to the writers, this approach has more value when applied to the process of talent development rather than the process of talent identification. It was the quest by researchers for a combination of the two approaches that led to the development of the so-called conceptual model of Règnier (1987) for talent identification (Spamer, 1999).

This model will referred to again later, as it forms the basis of the model on which this study is based. Before discussing the model of Règnier, other specific models for talent identification in sport, as designed by researchers, will subsequently be reviewed.

The Model of Harre (1982)

This German model can be described in the following way: the supposition is made that a young sportsperson can be classified as talented only by way of exercise. The role of parents and the social environment or ambience is important in the identification of talent. Harre (1982) emphasized a few important processes of his model.

The first process comprises two phases. The first phase is where all the children that have good, general ability are identified. The second phase is where the children are classified according to their abilities that they possess. The process that follows entails the identification according to factors that play a critical role in optimal achievement in their specific sports types.

The third process requires that each talent be regularly measured and evaluated on a regular basis, as the child increases in biological age. This part of the process requires that the child be evaluated, not only according to physical variables. Aspects such as psychological factors, attitude towards school, extra-mural activity involvement, and personality must be used as additional determinants. Harre's model is considered one of the most complete ones on talent identification. The only disadvantage of this model is that it cannot really be applied in a team sport setup.

The model of Havlicek et al. (1982)

This Czechoslovakian model is similar to Harre's model, and makes proposals regarding principles for talent identification. One of the most important principles is that sportspersons should be prepared sports specifically, i.e.: for a specific type of sport. To enable this principle, it is required that talented children be identified in physical education classes, and subsequently that they receive specialist training.

Early specialization in a certain sports type is not recommended, however. Selection criteria should be strongly based on genetic influences. Sport is multi-dimensional and all the variables need to be considered. The largest possible target population should be used, and this should take place within the greater context of talent development.

The model of Havlicek et al. (1982) emphasises the importance of hereditary factors and dependence on these for achievement. Heritage should not be over-emphasised however. The writers recommend a multi-dimensional approach however.

Gimbel's model (1976)

This German model views talent identification from three different angles: (1) physiological and morphological variables, (2) the ability to be coached and, (3) the motivation of the child. He distinguishes between the internal (genetic) factors and external (environmental) factors. These play a role in talent identification and further development.

He is of the opinion that a talented sportsperson who has been identified and who is between the ages of 8 and 12 years will need training before optimal performance will be achieved. According to him, it is important that youngsters with talent or potential be identified between the ages of 8 and 9. In his model, he also addresses the reasons as to why initially identified youngsters hardly ever reach the top (Gimbel, 1976).

Firstly, he states, the batteries of tests used for identification purposes are not valid, dependable or objective. In the second place, he also states that it is not possible to predict accurate achievement from the battery tests, as there are biological differences

within the same age groups. A third reason is that he feels that the contribution of psychological variables does not receive sufficient attention (Gimbel, 1976).

Gimbel's model can therefore be described as follows: it is a model in which morphological, physical, and psychological factors are essential and must be present for achievement or success in sport; furthermore, children need to be tested according to these variables and then referred to specific development programmes according to their results.

Subsequently, the children need to be regularly monitored for progress over the next 12 to 24 months. Lastly, a prediction about possible success is made for each child after the development program has been completed. The advantage of this model is that late developers are allowed sufficient time to develop and mature, and to even catch up to the others.

The model of Bompa (1985)

Bompa (1985) from Eastern Europe holds the following views regarding the advantages of talent identification: less time is needed to reach the top level, coaches work with talented learners, more athletes get the opportunity to reach international levels of competition, and sportspersons become more self-confident when identified.

According to Bompa (1985), three types of factors determine achievement in sport. They are:

- motor capacity (perceptual-motor skills);
- physiological capacity; and
- morphological variables.

Psychological variables are not referred to at all. The test results are then compared with existing norms of elite sportspersons, and talented people are identified accordingly. With reference to the various models presented, it appears that most of them follow the same basic principles and points of departure. This does not safeguard against certain problems, differences and weaknesses that they contain.

These can be summarised as follows:

- Combinations of variables lead to the attaining of peak achievement and success. These combinations differ from individual to individual however. Even so, the same results are achieved. It is therefore dangerous to accept that in the event that an individual possesses a number of variables, he/she will achieve success. Feldman (1986) points out that gymnasts who are short in length have an advantage over taller participants, but that the latter have other (specific) advantages such as height, diving and vaults. Bartmus et al. (1986) found these same results among tennis players. At this juncture it should be mentioned, however, that each type of sport does have certain basic requirements that can be considered primary requirements for top performance in sport. Salmela & Régnier (1983) proved that gymnasts younger than 12 years needed speed and power for the attaining of good results.

- A suggestion is that the emphasis on the demand for research in this field should be shifted to the combination of talent identification and talent development.

- Allowance should be made for the interaction between heritage and ambience. According to Malina & Bouchard (1991), the real interaction between the two components has not yet been properly or fully researched. It is known, however, that each individually, or both interacting together do influence achievement. It has been proven that the performance of marathon athletes can be predicted reasonably accurately in accordance with the intensity and quality of their training programmes (the ambience factors). A study by Blooms (1985) among tennis players and swimmers emphasized the effect of parental support on performance (ambience). Studies by Malina & Boucherd (1991) on twins clearly stressed the effects of inheritance on performance. Malina (1984) summarised her research on the effects of inheritance on motor function as follows: "evidence indicates a moderate hereditability for many motor

tasks with an unknown environmental effect."

- Longitudinal studies are necessary for identifying talent in order to be able to make objective deductions and draw objective conclusions. The different variables selected should be monitored regularly over a 3 to 10 year period. Variables with a low hereditary component normally tend to show signs of instability during longitudinal studies, because external factors exert such a strong influence upon them.

- Each sports type needs to determine it's own specific requirements, and the criteria should be evaluated from these requirements. The criteria must be multi-disciplinary and consider that variables change with an increase in age and exercise (Singer et al., 1993).

2.2.2.1) Conceptual model for talent identification

The Régnier model (1987)

When referring to the above descriptions of models and the subsequent discussion of their weaknesses, it becomes clear that with each model mentioned, the emphasis falls on individual sports types, as opposed to team sports types. Régnier (1987) constructed his own well-known conceptual model …"basing his model on the problems, shortcomings and suggestions made by researchers concerning the methodology of models of research on talent identification".

His model is very popular and is frequently used by researchers as a framework for their own work on talent identification. According to Spamer (1999), his model has been used successfully by researchers such as Jancarik & Salmela (1987) in gymnastics, Régnier (1987) in basketball and Pienaar & Spamer (1997) in rugby.

The major advantage of Régnier's model is that it can be successfully applied in the context of team sports. In order to meet the requirements of team sports, the researcher had to make use of a combination of variables, instead of individual variables, in his test

battery, e.g. a combination of dribbling and shooting goals in hockey, instead of separating the two variables.

According to the conceptual model, there are two essential phases. Phase one is where a thorough task analysis of the sports type is carried out in order to determine which variables play a part in ensuring success. In other words an analysis is done on the game-specific or sports specific requirements. Secondly, a further analysis is done on specific components, such as morphological, perceptual-motor, psychological and ambience factors.

This analysis is normally carried out by means of existing literature (test batteries), and the opinions of experts. Havlicek et al. (1982) are of the opinion that as many variables as possible should be involved during this phase. Both of the above phases, i.e. the identification of sports-specific (game-specific) requirements and the identification of determinants of performance will subsequently be discussed.

2.2.2.1 A) Identification of sport-specific requirements

In order to be able to develop a trustworthy model for identification, it is essential that all the possible variables that may play a role in performance be identified. The criteria in a prediction function consist of certain objectives that need to be met. The success of the sportspersons is determined by the extent to which they meet and comply with the prescribed sport-specific requirements (Hare, 1999).

This approach seems to be obvious and very simple, as is the case with certain types of sport. This is indeed true for some single-dimensional sports, such as swimming or running, where only one objective need be met. In this case, the prediction function is one dimensional in terms of time, distance or height (Hare, 1999).

In multi-dimensional sports, the situation gets more complex because several variables have to be carried out simultaneously, in order to determine a sportsman's success (Du Randt & Headley, 1993). In order to be able to determine what these variables are, a

thorough situation analysis of the requirements of the type of sport needs to be done. In certain cases this can be done through observation and the opinion of experts. Mainly two methods are used for this purpose, namely the so-called divertical (top-down, "bo-na-onder") approach, and the evertical (bottom-up, "onder-na-bo") approach (Singer et al., 1993).

The devertical method makes use of orthodox scientific methods. The situation-analysis is based on how the type of sport is currently practised, and how success can be obtained by means of a hypothetical conceptual model; for example, in order to be able to run fast, one needs speed (Hare, 1999).

Comparing certain variables with one another, where one variable, the variable that needs to be described, is the dependent variable (ability to run fast) and the other the independent variable (speed), usually does this. This will be discussed in more detail later in this chapter.

The evertical approach aims at finding out from top performers which aspects caused top performance. This is done by means of interviews, protocol analysis, and recalling performance (questionnaire) (Hare, 1999).

Singer et al. (1993) is of the opinion that, as soon as too many variables have to be analysed, results are questionable. After the essential determinants of performance had been determined, the identification of specific determinants of performance should be done, by means of specific tests combined in a prediction function. The identification of these determinants of performance will subsequently be discussed.

2.2.2.1 B) Identification of determinants of performance

In order to draw up a dependable test battery, a second task analysis needs to be done. This analysis is done to determine which underlying functions are essential for the sportsperson's performance. These underlying variables comprise mainly morphological, psychological, motor, and environmental factors. This task analysis is

done with the aid of existing literature and of experts on this topic, in order to compose a list of determinants of performance. In this case, devertical and evertical approaches can also be followed (Hare, 1999).

It is also advantageous if the predictors are of a genetic nature, as the chances of its realization will be better, because it can be developed (Du Randt & Headley, 1993). With reference to the development of a dependable identification model (Salmela & Régnier, 1983), the authors make use of the so-called "sliding populations" ("glypopulasie") principle (Hare, 1999).

This means that instead of monitoring the same population group from juvenescence to adulthood, the process of testing is carried out during various age-phases and on various population groups. A specific or unique test battery is designed for each age group. This identification model or test battery aims to select, from a specific pool population, those sportspersons who possess the possibility to reach the elite level of the next age group, known as the "target population" (Hare, 1999).

It is important during the selection of the pool population to involve as many persons as possible, in order to ensure that late developers with talent are also accommodated. It is also important that sportspersons who are part of the "pool population" should not afterwards form part of the target population. It is characteristic of the above model that some of the talented persons who performed well, were more obedient, dependent, and studious (Hare, 1999).

Certain researchers have expressed the opinion that a characteristic of this model that should be taken into account is the high dropout rate of initially identified so-called talented persons (Csikszentmihayi & Robinson, 1986). Jerome et al. (1987) found it characteristic of these dropouts that they experienced an identity crisis, become sexually mature and undergo other physiological characteristics at the same time.

From the discussion of the conceptual model of Régnier (1987), it can be said that it provides for most of the principles which research on talent identification has to adhere

to. It also describes in detail how each step has to be carried out. In addition, it emphasizes the importance of the multi-disciplinary approach. It also describes a thorough statistical process, which keeps in mind the interaction of various morphological, physiological, psychological and environmental factors as well as sport-specific requirements (Hare, 1999).

So, as can be seen from the above description of the conceptual model of Régnier (1987), it is probably the model best suited for the needs of this study at the present stage.

To conclude, one can set the following guidelines from the above discussion:

- talent identification is a continual process. This means that it occurs during various age phases and that it must be coupled to development. Norm scales for development should exist;

- a model of talent identification should:
  -supplement but not replace the coach;
  -make provision for late developers;
  -make the group that is initially selected as large as possible; and
  -have a multi-disciplinary approach. This means that the Physical Education teacher has a role to play as does the medical practitioner, the sport scientist, etc. It also comprises various components, e.g. physical and motor, anthropometrical, psychological, and game-specific;

- the components essential for top performance in each type of sport have to be analysed. An example is in rugby where handling, running, catching and passing kicking will be important components, and in netball where catching and passing, response time, speed, etc. are important components.

- biological and environmental factors must be considered. In young children, psychological factors may possibly be less important than anthropometrical

factors. The culture and background in which a child grows up may inhibit or facilitate talent identification;

- criteria for selection should strongly support the genetic components. This refers to components such as speed, balance, coordination, suppleness, and strength;

- rate of development should be constantly monitored. The rate at which improvement occurs is an important indicator of talent (Spamer, 1996); and

- a test battery should comply with the following:

- It should be simple and practical.
- It should make use of simple apparatus.
- It should need a limited number of personnel.
- Tests must be easy to administer.
- Test batteries must be composed in accordance with scientific findings.

Phases of talent identification

The Russian and Australian models of talent identification are generally known these days. The process is divided into three phases, namely:

Phase 1

This comprises mass evaluation (population) for the age group 8 to 10. Classification functions (abbreviated test batteries) are normally used to select the best talented persons. Selection is not strict, and border cases are included rather than excluded. This potentially talented group then follow a specific development programme in order to improve their talents.

Phase 2

This phase follows 18 to 24 months after phase 1 (age 11 to 12 years). During this phase, the talented group follow a development programme. Monitoring of improvement occurs regularly (monthly, half-yearly, or yearly). Full test batteries are used, not only

prediction functions.

Phase 3

During this phase, final talent identification takes place (± 13 to 14 years). The selected groups then receive further specialist coaching (Pienaar & Spamer, 1996).

In summary

For the coach involved in talent identification, it is important to understand how to talent is determined:

- firstly, all test persons are tested and subsequently evaluated in accordance with the results of talented persons. The coach also makes use of the prediction function in which everybody is tested and sportspersons rated in a ranking order from talented to less talented. In order to be able to determine the latter, the coach can send the raw data to the writers for processing, or may apply the formulas themselves as explained later;
- after a talented group has been identified, they should be exposed to a development programme;
- talented people must be regularly monitored by means of a complete test battery;
- being talented seems to be age-specific. This means that a ten-year old talented person will not necessarily perform well at an age of 18 years. More research needs to be done on this;
- do not totally ignore children who seem to have less talent. They may rise above the rest at a later age because they do have the talent, but may have an initial handicap due to late development; and
- as the development process progresses (skills programme), children must constantly be evaluated against norm scales in order to monitor tendencies such

as insufficient power or speed (Pienaar & Spamer, 1996).

2.2.3) TALENT IDENTIFICATION IN SOUTH AFRICA

Prior 1933 studies concerning talent identification in South Africa received little attention. Some studies to identify talented individuals were conducted by Daehne (1983) in athletics and Pienaar (1987) in gymnastics. The re-admission of South Africa to the international sporting arena has given South African sports governing bodies, administrators, sportspersons and researchers a new perspective regarding the demands of international participation (Spamer, 1999).

It was clear that South Africa had lost ground in the field of talent identification, as the isolation years had made us the pariah of the modern world. While the rest of the world continued to compete and develop new methods, we did not have much access and credibility, and hence did not advance as far the others.

On the scientific terrain, Du Randt (1993) made an important contribution to research in South Africa in her study of a perspective concerning talent identification on international and national levels. This assignment was carried out on behalf of the department of national education and had as main themes the identification of talent, physiological, psycho-social and anthropometrical variables, talent identification in the old Communistic and Western countries as well as suggestions and recommendations concerning research on the identification of talent (Spamer, 1999).

Some of the research referred to in this study has been confirmed by Du Randt (1993). In the light of the fact that research on the identification of talent is relatively unknown in South Africa, she has succeeded in laying down basic guidelines according to which a model for talent identification in South Africa can be drawn up.

There is also a brief overview of priorities for further research. The section on the identification of talent in South Africa, with some research results in this field that have been ongoing since 1993, will then be investigated (Spamer, 1999).

We are fortunate that South Africa woke up to the fact soon enough that research in this field needed to be conducted, firstly by analysing what the rest of the world was doing, but also developing our own methods that can be applied to the unique situations in which we find ourselves in this country. It is possible that South Africa can become one of the world's leaders regarding talent identification, and that the backlog that we started with can soon be caught up.

The guidelines according to which talent identification can be done were described by Du Randt & Headley (1993). Only the main issues, as supplied by them, are given.

- The identification of talent must be a continuous process because test results are only valid for 2-4 years after which time new norms are necessary

- National and regional programmes which stress general fitness should be encouraged

- Research models must also emphasize the following: in addition to the coach it must be taken into consideration that requirements according to age should be determined; provision must be made for late developers to catch up; as many individuals as possible should be involved and have a multi-disciplinary approach

- Test batteries for initial selection of talented individuals should be simple and practical, easily administered and yet always scientifically founded, should be simple and practical, be easy to administer, yet must always be scientifically based.

- Coaches and national bodies of sport should be trained and be made a part of talent identification.

- The conceptual model as suggested by Régnier (1987) is recommended, but the Russian model can be used with good results.

The study by Du Randt (1993) also made suggestions as to how sports scientists should pay attention to and approach further research in the future. A talent identification model should be developed for each type of sport. Quasi-longitudinal studies based on Régnier's sliding population principle, should be executed.

Norms for talented individuals within the South African population should be laid down and the effects of growth and development on hereditary must be calculated. In addition, a scientifically valid and dependable test battery for talent identification needs to be created.

Since the study by Du Randt (1993) published the South African government, during 1995 and in conjunction with the National Sports Council, confirmed that the formation of a national sports policy is a high priority. Several national and provincial programmes have since been started in order to obtain data. The training of researchers also received high priority, in the form of overseas training. Since then, a few scientific studies have been published.

There have been some valuable contributions however, with a few prominent researchers becoming specialist in their areas of interest. Included in the list are the names of Pienaar and Spamer.

Pienaar & Spamer (1995, 1996, 1997) and Pienaar et al. (1998) have made valuable contributions, especially in the field of rugby, to identify talented young players (Spamer, 1999). Their research showed that 10-year old rugby players, who had been identified as talented, were included in the Craven week primary school team with great success three years later. The total course of the identification process from a statistical processing viewpoint was described in detail by the researchers (Pienaar at al., 1998).

Pretorius (1996) also researched juvenile rugby players and described various prediction functions for different players' positions, to be used very effectively by coaches. Van der Merwe (1997) researched the effect of a rugby specific development programme of 11-year old identified talented rugby players. His conclusion was that

talented people can, indeed, be identified by a prediction function, and that they performed much better than non-talented people during a development programme.

Hare (1997) drew up a prediction function for 16-year old rugby players, in which he assessed not only anthropometric, physical, and motor and game-specific skills, but also psychological variables that can play a role in top performance.

Badenhorst (1998) did research on 15-year old soccer players and compiled a talent identification battery which can be applied in practice, with excellent effect. Recently completed studies include a longitudinal study on rugby by Hare (1999), and even a study on talent identification in hockey.

Although during the past five years, definite progress has been made in research on talent identification, this remains an unexplored field in South Africa. Tertiary institutions in sports institutes should take the initiative of stimulating more research in this field. Closer liaison with provincial and national sports bodies in order to identify needs should also be a priority.

2.2.3.1) CONCLUSION

From the literature, it appears that, especially during the last decade, much research has been done on talent identification. Many of the results of these studies led to talented juvenile sportspersons being identified, which afterwards led to top performance. As far as the situation in South Africa is concerned, scientific studies on the topic are relatively few.

Although this matter is currently receiving attention nationwide, a special effort will have to be made to have more scientific research done. In this way, it will be ensured that talented juvenile sportspersons be identified in each type of sport, enabling them to follow specialist development programmes.

From the above references to literature, it is clear that scientific studies in talent identification, and specifically in South Africa, have to adhere to certain basic principles. This chapter is concluded with the laying down of several guidelines for the process of talent identification that may be used by researchers in South Africa.

These guidelines should not be seen as the alpha and omega of talent identification, but may be used by researchers as a starting point.

1. Research should be focussed on both individual and team sports. It appears that, at present, in South Africa, only rugby, soccer, hockey, gymnastics, and some athletic items actually have research results to show.

2. It should be endeavoured, by means of research, to create test batteries for various age groups in all types of sport. From the literature, it appears that intervals of 3 years may be effective, e.g. 10, 13, and 16-year olds.

3. Talent identification is the initial phase, and talented people need to be subsequently introduced to a development programme. Such development programme should run for a period of 3 to 10 years, as it takes time to reach top performance. It is essential that, during the first three years, attention must be paid primarily to the development of general motor abilities, and that actual sport-specific coaching should take place only in the last 3-5 years. If longitudinal studies do not seem to be possible, quasi-longitudinal studies should be used.

4. Test batteries should be developed for identification at various ages (3 year intervals). For such testing, all possible sport-specific, anthropometric, physical and motor, and psychological tests should be included. These tests are aimed at determining which components are present in top performers.

5. The actual empirical process must be refined as follows:

   - as a first step, two groups are identified, i.e. talented and less talented

participants, who are subjected to a maximum number of sport-related tests. (Pienaar et al., 1998; Dixon, 1990). By the use of step-by-step discriminant analysis, as referred to in the literature, tests are selected, which will comprise the test battery. The population in question is then tested in accordance with these tests. This discriminant analysis aims at selecting tests that discriminate maximally between the talented and non-talented groups.

- After the population, or a large random sample have been tested as described in the sub-paragraph above, a canonical analysis should be done, using the first canonical principle, in accordance with which all persons involved in the test must be positioned in a ranking order.

- The top group (talented group) must be further subjected to a development programme. Care should be taken that groups are not too small, in order to make provision for late developers and dropouts.

6. Regular monitoring of performance is essential. As soon as sufficient research has been done, a scale of norms will exist, by means of which performance can be measured

Finally, the coach, in terms of having a scientific background and knowledge regarding battery tests, the parents, in terms of giving moral support and showing interest in the progress of their children and the community, in terms of providing facilities and financial support, will always play a role in top performance by talented people. And will therefore form an essential part of talent identification.

2.3) STATISTICAL METHODS

When it comes to data analysis, there are mainly two methods whereby research models were composed. According to Singer et al. (1993) the two approaches or methods used to compose models are referred to as the so-called devertical ("top

down") approach and the evertical ("bottom-up") approach.

There are numerous methods of research used worldwide, but two of the more commonly used or popular methods are called single variable studies and multi-variable studies. The first method, single variable studies, has the disadvantage that it is capable of using one variable when comparing achievers and non-achievers. In the field of talent identification, where numerous factors play a role and where you cannot merely focus on one factor, this method is highly limited.

The second method, namely multivariable studies, eliminates the above problem found in single variable studies, as various variables are tested by means of statistical methods, and the underlying relationships between variables can be determined. This is a more realistic approach, and one where all the factors involved in talent identification can be exhaustively examined and even compared in terms of importance.

A well-known example of this type of study is where two experimental groups are selected, one group of which has performed well, and another group that has performed less well. The two groups are measured according to morphological, physical, and morphological, physical, and motor, psychological, and game-specific variables.

The two models of sports talent identification being evaluated by this study are both multivariate models. This therefore warrants a further investigation into the types of multivariate techniques that are available to researchers, and an explanation of the factors involved.

2.3.1) Types of multivariable techniques

Multivariable techniques can be broadly divided into two main groups, namely dependence methods and independence methods. All dependence methods are characterized by a distinction between dependent variables and independent variables. Dependent variables are those that are characterized or explained by the independent variable (Diamantopoulos & Schlegelmilch, 1997).

Diamantopoulos & Schlegelmilch (1997) then go on to explain that to identify the multivariate technique to use, you need to determine whether your data permits you to distinguish between dependent and independent variables. In this case, the answer is yes. Therefore, the models under discussion are both dependence variable models.

An illustration should suffice at this point. The data is such that there can be a distinguished between dependent and independent variables. The dependent variable is explained by the independent variables. Therefore, in the case of this study, for argument's sake, the dependent variable is sports talent (or lack of it) which is described by the independent variable(s) i.e.: speed, agility etc.

Then clarification is needed regarding the dependence methods. The first area of clarification needed is the number and measurement level of the dependent variables. If you are dealing with just one dependent variable and this one variable is measured on a metric scale, you most likely require a multiple regression analysis. If, in contrast, your one dependent variable is non-metric/binary, you should have a look at multiple discriminant analysis. For both kinds of analysis, your independent variables should be metric (Diamantopoulos & Schlegelmilch, 1997).

2.3.2 Logistical regression

As seen from above, when your dependent variable is measured on a metric (numeric) scale, multiple regression analysis will need to be done. For this study, logistical regression is used. According to Kleinbaum (1994) *…"the logistic function, on which the model is based, provides estimates that must lie in the range between zero and one".*

The closer a result gets to statistical significance, the smaller the P-value gets. Therefore, if you have a $p < 0.05$, you have a significance at a 5% level, or in other words the hypothesis of no relationship (or no difference) is erroneously rejected only 5% of the time. This is a common form of reporting that has been seen over the years in the South African context.

As stated previously, the aim of this study is a comparison of the predictive ability of the two methods currently under discussion i.e.: logistical regression and discriminant analysis. According to the method of logistical regression, using the data that has been captured, the subjects will be classified as talented or less talented by making use of only one dichotomous dependent variable (i.e.: a variable having two distinct values).

Therefore, using the information regarding the subjects in the form of independent variables, each category's (talented vs. non-talented) data will need to be imputed respectively. The limitation of this method is that, unlike the method to follow, only one dependent variable can be measured at a time and in so doing requiring the researcher to test both groups separately should groups be the focus of comparison.

The basis and bulk of this information is derived out of Diamantopoulos & Schlegelmilch (1997) out of their book *Taking the Fear out of Data Analysis,* with adaptations done so as to make it clear to the reader where the application for this study is done.

Multiple regression analysis *(i.e.: logistical regression)* is a method used to analyse the relationship between one dependent variable and a number of independent variables. Both the dependent and the independent variables need to be metric, i.e. measured at interval or ratio level (independent variables can also be in the form of 'dummies' i.e.: indicating whether a phenomenon occurs or not) and therefore being numeric in nature.

The aim is to predict the presence of talent, by means of batteries of tests that were executed. What the reader must bear in mind, however, is that the groups are known and previously identified as being talented or not (see chapter 1 for more details). This study focuses on the accuracy of the predictive function of each of the models i.e.: do they distinguish known groups into their respective groups or not?

For the sake of this discussion, it can be assumed that the talented group is under investigation at this point (whereas the less talented group will also be reviewed according to the same process). As stated before, certain batteries of tests were utilised for this study, so as to accumulate scores needed for the predictive functions of these

models.

The next step would be to input each of the scores (the so-called raw data that have been statistically evaluated) that were achieved into the model. Ordinarily, when dealing with an unknown group, it can usually be assumed that each of the variables will affect whether the group is talented or not. The tests performed were exhaustive, investigating each of the previously identified categories of talent (for more information, consult chapter one and three). In total, there were between twenty and thirty tests performed.

Multiple regression analysis or *logistical regression* is therefore, in this context, the ideal analysis technique for this task. It not only enables the prediction of the dependent variable but also provides an assessment of the relative impact of each of the independent variables; moreover, it would indicate the *combined* ability of the independent variables in explaining the variation in the dependent variable.

The fact that the impact of each independent variable is measured, is, in practice of great help to the coach, researcher or anyone dealing with talent identification. When the identifier knows what tests best predict talent, a time saving aspect can therefore become an advantage to this model, albeit not initially.

Therefore, in the case of this study, the relative impact of each of the independent variables with relation to the dependent variable was determined and analyzed. If the impact was of little or no effect, it was discarded and the next variable was then imputed and analyzed until all the variables had been through the whole process. The best predictors were then selected according to their impact, and noted as being better selectors. The results of this can be seen in chapter 4.

For the sake of this discussion an example of the notation of the logistic transformation has been included below. The probability that a subject falls into one group (say MSP) as a function of the scores obtained on 4 tests, is given by:

$$P(X) = \frac{\exp(A + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4)}{1+ \exp (A + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4)}$$

When the above formula is evaluated, the following can be stated:

The terms **A** and function **exp (Y)** means **e** to the power **Y**, where **e** is the constant **2.7182818.** The terms **A** and **B_1 to B_4** are the unknown parameters that need to be determined. The **X_1 to X_4** known parameters that are substituted into the equation. Therefore, the **X_1 to X_4** parameters can be the scores that have been attained in the tests.

The details of this method are complicated. It is however important that the reader has a firm understanding of the basic principles that apply to this predictive function method. In summary, the following about this method can be said:

The dependent variable is what is being investigated (in this case it is the presence of talent or not-in this case known as the groups have already been classified). The independent variables are the factors that affect the dependent variable and have a certain level of impact on the dependent variable. Both the dependent and independent variable need to be metric, or in other words numeric.

These are substituted into the above method so as to derive certain results, so as to see whether the method predicts accurately that which is already known. The variables or factors can also then analysed so as to determine their impact. The whole idea here is that the result is already known, but that the prediction accuracy of the method is being tested to see how accurately it predicts success or the presence of talent. If the method is found to be accurate, it can be used with confidence to predict success in future data.

2.3.3 Discriminant analysis

Multiple discriminant analysis (in short-discriminant analysis) is used to analyse differences between groups in terms of several variables simultaneously. It is conceptually very similar to multiple regression analysis, the difference being that the dependent variable is now non-metric/binary (i.e. a nominal variable defining group membership) (Diamantopoulos & Schlegelmilch, 1997).

Discriminant analysis therefore allows for the analysis of differences between groups in terms of several independent variables simultaneously. The added advantage of this method is that comparisons can be drawn between groups. It even goes further so that identification of the best independent variables is possible, ranking them in terms of importance or significance.

This prediction method has an advantage in that you can analyze many variables simultaneously as well as differences between groups and even go as far as ranking variables according to importance or significance.

For example, if you would like to find out whether talented and less-talented athletes (a dichotomous variable) to differ in terms of, for argument's sake abilities in speed, running and catching and measurement in triceps skin fold, and any number of other factors discriminant analysis would be the technique to use.

The results would tell you whether talented and less talented score differently on these variables, and also identify which variable is the best, second best, third best, etc., in terms of discriminating power. In addition, the results could be used for prediction purposes, i.e. to classify people, for whom you do not know whether they are talented or less talented into one of these categories based on knowledge of their abilities in speed, running and catching and measurement in triceps skin fold, and any number of other factors for which you have made provision.

In most applications, the dependent variable in discriminant analysis is dichotomous (for example, talented versus non talented; flyhalves versus scrumhalves), but the technique is also applicable when a multichotomous dependent variable is involved (for example, flyhalves versus scrumhalves versus fullback).

As stated earlier in commentary on this method, the possibilities abound. When raw scores are obtained, the raw scores can be imputed into this method, with a classification being made regarding whether this subject(s) is talented or not. The results are quick and easy to obtain.

Comparisons can also made intra-group where a complete rugby team may be compared to one another in terms of strength and scores obtained in various tests. This will enable the coach or the researcher/scientist to make comparisons of different players in different positions according to relative abilities.

While it seems obvious that, in theory this may be the better method, one cannot argue that the previous method has numerous advantages of its own that can be highly desirable in practice. As researchers and in fact a country that is always seeking better ways of doing things, the previous method is deserving of investigation as this study is aiming to accomplish.

Therefore, unlike the previous method, this method can, in effect provide a broader view of two opposing groups and even rank certain factors (or independent variables) as being more important or significant than the next. The possibilities regarding this method abound.

It must be mentioned that a stepwise discriminant analysis is firstly used to identify the best discriminating factors (SAS/STAT User's Guide, 1989). This has an advantage in that it provides a more focussed look at these individual factors and that it allows the researcher to discount those so-called unnecessary variables or factors. In so doing, a more accurate result can be obtained, with all the unnecessary, and potentially complicating factors excluded.

CHAPTER THREE

EMPIRICAL INVESTIGATION

In this chapter the methods and procedures followed in this study will be examined and discussed. It is necessary to evaluate and discuss the history behind talent identification. For information regarding this, a review of chapter two will be needed. In this discussion, two phases will be presented. Phase one is not primarily part of this study, but will be reported as it forms the basis of phase two.

As mentioned above, the history behind the process is essential as to understand why certain procedures are followed and to give the reader a basic understanding of the thought processes behind phase one, and ultimately an understanding as to why phase two is executed in the way that it is.

3.1) PHASE 1

3.1.1) Talent identification in rugby

The research started in 1994 by Pienaar & Spamer (1995) and Pienaar et al. (1998) with 11 year-old boys and the research conducted by Hare (1997, 1999) with 16 year-old boys will act as a basis for this discussion.

3.1.1.1) Talent identification in youth rugby players: a game analysis

After a thorough situation analysis of the requirements for the game of rugby with youth rugby players was done, it became apparent that the basic skills and abilities a player needs are handling (catch and pass), running, kicking, speed, agility, strength and endurance (Guy et al., 1991; De Ridder, 1993; Strand & Wilson, 1993; Pienaar & Spamer, 1995).

The only test-battery, which could be found in related literature and which tests most of these components is the AAHPER - rugby skills test (1966). This skills-test consists of three handling and running skills, two kicking skills and two motor skills that are related to rugby. To adapt these skills, which are devised mainly for American (Gridiron) Football, to rugby football, the carrying out of movement (throwing skills) and apparatus (rugby-ball) had to be adjusted. The method of throwing has been changed from throwing with one hand above the shoulder to a lateral passing with both hands.

Although the ball used in America is not very different from the ball used in South Africa, the standard number 4 and 5 ball is used with youth players in the carrying out of the test battery. The carrying out of the speed and agility tests have remained the same. The validity and reliability of these tests (standard and adapted) have been tested by the BMDP-6M statistical programme (Dixon, 1990). The test-re-test-correlations, which varied between r = 0,86 and r = 0,94, indicated that the changed tests are valid and dependable.

Because the correlations are so high, the American tests were removed from further test-batteries and only the adapted tests are used. The rugby- specific tests that are used for youth players are passing for distance, and kicking- off for distance. A speed endurance test (Hazeldine & MacNab, 1991) and a self-devised test for passing accuracy over 4 m (Pienaar & Spamer, 1995) have been included in the test-battery.

The situation-analysis indicated that physical abilities such as strength, endurance and suppleness are also important requirements for success in rugby. Tests of this nature have been included in the test-battery. They are the bent-arm hang test (static strength) the sit-and-reach test (suppleness) and the vertical jump test (explosive strength) (Johnson & Nelson, 1984).

Eighteen anthropometric components were also measured, viz. body-length, body-mass (weight), two skeletal cross-sections, two muscle circumferences and eight skin-folds. Somato-typing, fat percentage, correction of the arm (upper-arm circumference corrected) and the calf (calf circumference corrected) as well as the relationship between body-mass and body-length are also calculated. (Hahn, 1990; Malina & Bouchard, 1991; Bloomfield et al., 1994).

3.1.1.2) Methods of talent identification in youth rugby players

It is apparent from related literature and practice there are basically two methods that can be followed for the identification and development of talent. These two will be examined in more detail.

A. Selector selection

According to this method a number of promising talented players are identified by a group of selectors. This selection is done on aspects such as physical appearance, speed, skill and decision-making. After the group of players has been put together using this method, a thorough testing must be done.

The components that are tested according to this are game specific, motor-physical, anthropometric and psychological. For the purposes of this study, the psychological aspects were not taken into. The complete battery of tests containing the above aspects will be described later. When the selected group has been identified, the players must be placed in a rugby development-programme. Primary aspects that need attention are game specific skills, strength development (gymnasium work), plyometric strength and speed.

B. The use of prediction functions

This method has been developed from a large number of tests that were carried out on rugby-players. According to these tests it was determined which variables distinguish between players who are successful (talented) and players who are less successful (less talented players).

Discriminant analysis was used as a statistical processing method. This method means that instead of using a large number of tests a smaller number is used and that concentration is focused on those variables that primarily distinguish between achievers and those who are lesser achievers.

The advantage of this is the time factor, and the fact that time is not wasted on a number of factors that need not be taken into consideration. This method of selection is aimed at selecting potential players from the masses. The fact that there are fewer tests provides time to test the masses that, as mentioned above, is an advantage, especially in the field. The results as obtained from the moderated test-battery (prediction function) can be read into the formula.

The scores are processed by a computer and are compared. The highest value (talented or not talented) determines where the player will be placed. In this way it can be decided to use the 40 best scores of talented rugby-players to put together a group of players who can follow a further developmental programme.

As a result of factors such as late development, being unfit etc. it can happen that talented players are wrongly predicted by the statistical function. As a result of the same factors, it can also happen that some players are identified as talented to only later become drop-outs. It is also always advisable, on the recommendation of the coaches to add players who were initially not identified by a prediction function, to the group.

When the players have been identified they must follow a developmental programme based on rugby skill. It is important that these players are regularly monitored according to the full test-battery in order to determine development and to adapt the content of the programme should weaknesses arise.

The reasoning behind this study is as follows: as seen above, it is historically significant that discriminant analysis is generally used as a statistical basis of interpretation of the results obtained. The need became apparent, therefore, to ascertain whether these same results can be obtained through the implementation of logistical regression as a method of interpretation, an equally time saving method, regarded in some parts of the world as a better predictor than discriminant analysis.

It is logical then, that should there be a more accurate predictor than the method currently in use that it should be seriously considered and possibly even be adopted. While the above description of discriminant analysis is a basic exposé of the method's advantages, a more thorough review of both methods' advantages and disadvantages be examined by the reader in the chapters preceding and following this one.

For the sake of expediency there will now be a review of phase 2 with a full description of the test-battery followed in this study.

3.2) PHASE 2

3.2.1) A brief description of the full test battery

After phase 1 was completed, phase 2 then commenced. What follows is a brief overview of the different components tested after which a more in-depth discussion will follow. The components include rugby specific, physical-motor and anthropometrical components. These are components that were identified in phase 1 as being of importance to achieve success in the game of rugby. The components are the following:

A) Rugby specific components

- Passing for distance
- Passing for accuracy over 4 metres and 7 metres
- Kicking for distance
- Kick-off for distance
- Running and catching

B) Physical-motor components

- Vertical jump
- Speed endurance
- Agility run
- Speed
- Flexed arm hang

C) Anthropometric components

- Body mass
- Skin fold measurements: triceps, sub-scapular, medial calf and supraspinal
- Circumferences: upper-arm girth and calf girth.
- Cross-section measurements: humerus and femur breadth.

3.2.2) In-depth description of the full test battery

A) Rugby-specific components

A full description of the tests carried out, as well as the apparatus needed to determine the rugby-specific components follows:

1) Passing for accuracy over 4m

Apparatus: A metal circle with a diameter of 50cm that has been mounted on a vertical base 50 cm from the ground that acts as the target. One rugby-ball. *Method:* While the player runs in a line parallel to the circle target he must pass the ball through the metal circle which is 4m away. A pass through the circle is regarded as correct. The respondent has five chances to pass the ball through the circle from the right and five from the left. The respondent's total success-rate (1 point per successful pass) is noted (Pienaar & Spamer, 1995).

2) Passing for accuracy over 7m

Apparatus: A metal circle with three different circle-sizes within it, viz. a diameter of 60cm, 120 cm and 180 cm; a metal measuring-tape and a rugby-ball. *Method:* The respondent stands 7 m away from the circle and gives an ordinary or a scrumhalf pass to the target. The point-value of the different circles is as follows:

- Inner-circle-60cm-3pts
- Middle-circle-120cm-2pts
- Outer-circle-180cm-1pts

A pass that touches the circle receives a higher points allocation. Ten attempts are allowed and the total of all the attempts is recorded. A maximum of 30 points can be achieved (AAHPER, 1966).

3) Kicking for distance

Apparatus: 50 m measuring-tape and a rugby-ball.

Method: The respondent takes the rugby-ball with both hands and, using their foot of preference, tries to kick it forward as far as possible. The respondent may make use of a run-up. Three attempts are allowed. The best of the three is recorded (AAHPER, 1966).

4) Kick-off for distance

Apparatus: 50 m measuring-tape, a tee and a senior rugby-ball.

Method: The respondent places the ball on the kick-off tee and, using an unlimited run-up and the foot of preference, kicks the ball as far as possible. Three attempts are allowed and the longest distance is recorded (AAHPER, 1966).

5) Running and catching

Apparatus: Measuring-tape, markers and a rugby-ball.

Method: At the command "Go" the respondent runs from marker B (see figure 1) to marker D where he makes a 90° turn towards marker A. Between markers A and D a rugby-ball, using a lob-pass; is passed to him. It must be caught while in forward motion. He runs around marker A and back to B and throws the ball back to the thrower. The action is repeated to the right. Ten attempts are made to the right and ten to the left. If the respondent catches the ball he gets one point (AAHPER, 1966).

The highest score will thus be 20 points (ten to the right and ten to the left).

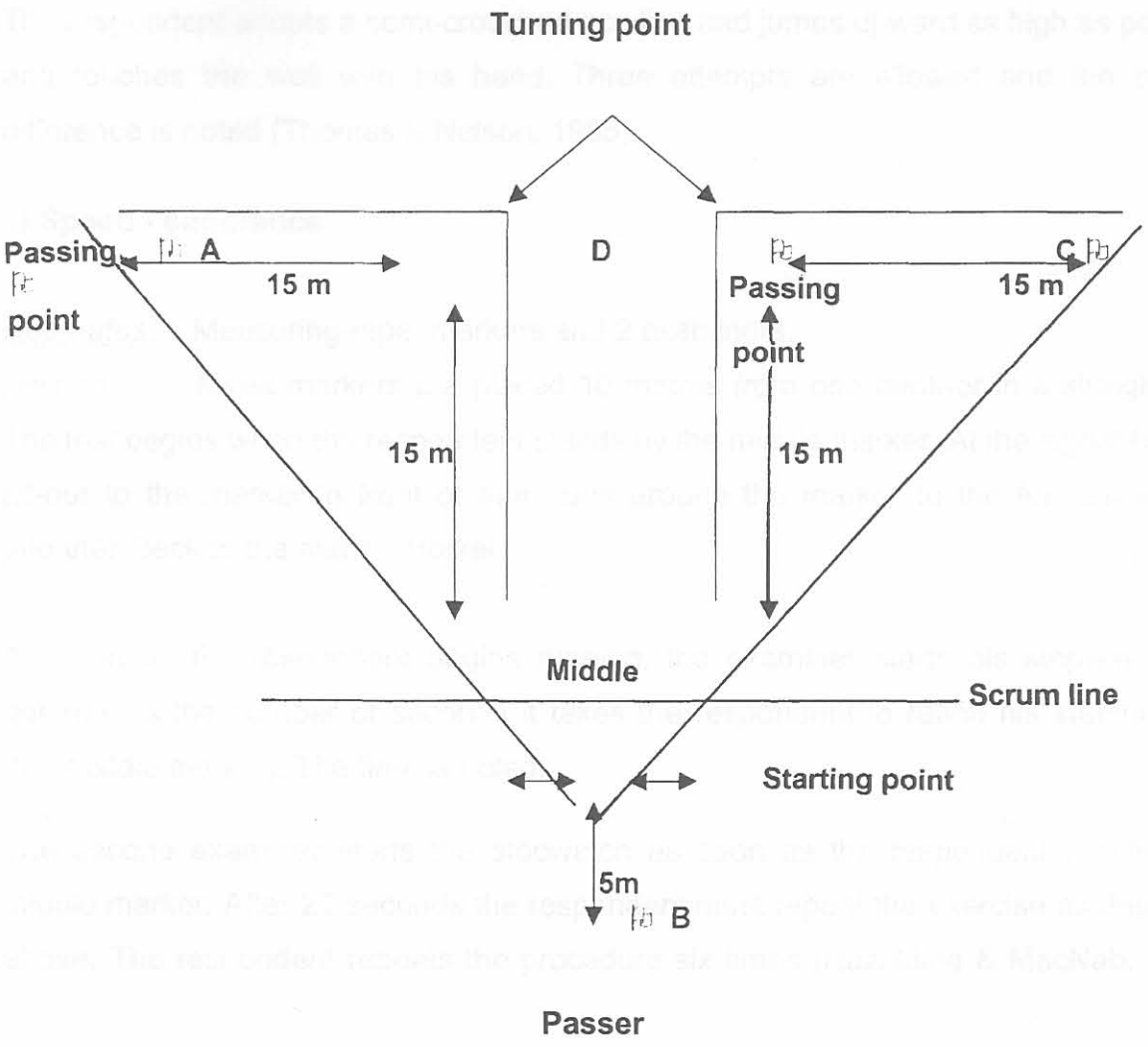

Figure 1: Running and catching

B) Motor-physical abilities

In the following section the physical and motor-skills variables that measured, as well as the techniques and apparatus used in the measurements are discussed.

1) The vertical jump (explosive strength)

Apparatus: Magnesium powder and measuring-tape.

Method: The respondent stands sideways to a wall and stretches the arm nearest to the wall above his head. A mark is made where the respondent's middle finger touches the wall.

The respondent adopts a semi-crouched position and jumps upward as high as possible and touches the wall with his hand. Three attempts are allowed and the biggest difference is noted (Thomas & Nelson, 1985).

2) Speed - endurance

Apparatus: Measuring-tape, markers and 2 examiners.

Method: Three markers are placed 10 metres from one another in a straight line. The test begins when the respondent stands by the middle marker. At the signal he runs all-out to the marker in front of him, runs around the marker to the furthest marker and then back to the middle marker.

As soon as the respondent begins running, the examiner starts his stopwatch and determines the number of seconds it takes the respondent to reach his starting-point (the middle marker). The time is noted.

The second examiner starts the stopwatch as soon as the respondent reaches the middle marker. After 20 seconds the respondent must repeat the exercise as described above. The respondent repeats the procedure six times (Hazeldine & MacNab, 1991).

All six attempts are recorded and the speed-endurance is calculated as follows:

1. $\frac{(Y_1+Y_2)}{2} - \frac{(X_1+X_2)}{2} = Z$

2. $Z \div \frac{(Y_1+Y_2)}{2} \times 100 = X\%$ where

- $(X_1 + X_2) \div 2$ = average X (where X_1 and X_2 are the two slowest times).
- $(Y_1 + Y_2) \div 2$ = average Y (where X_1 and Y_2 are the two fastest times).
- Average Y - average X = Z.
- Z ÷ average Y x 100 = % decrease in speed endurance.

This percentage indicates the percentage decrease in speed endurance in the respondent. The smaller the percentage, the better the speed endurance.

3) Agility run

Apparatus: *1* marker, 5 posts/persons, a stopwatch and a rugby-ball

Method: See figure 2 for the description. The respondent lies on his/her back with the heels towards marker A. On the command "Go!" the respondent does a shoulder-roll. At marker E there is a rugby-ball that is picked up by the respondent who runs around markers F and G. The respondent runs in a zigzag fashion through the markers H, I, J, K and L to the finishing-line. The respondents have two chances and the best effort is noted. The time is measured to the nearest 0,1 (one tenth) of a second (Bloomfield et al., 1994).

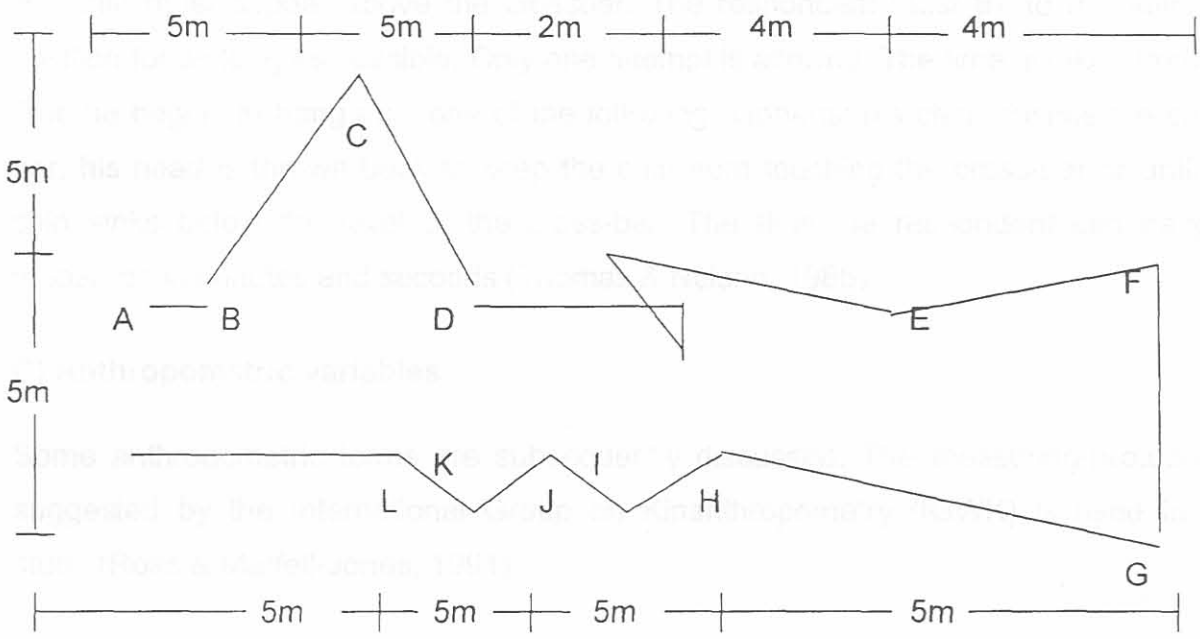

Figure 2: Agility run

4) Speed-test

Apparatus: 50m measuring-tape, a stopwatch and a rugby-ball.

Method: Two attempts over 45,70 m are allowed and the best time to the nearest 0,1 (one tenth) of a second is recorded. The respondent runs with the ball under his arm (AAHPER, 1966).

5) Flexed-arm hang

Apparatus: A crossbar high enough off the ground so that the respondent's feet do not touch the ground during the test, a stop-watch to determine the respondent's "hanging" time.

Method: The respondent is lifted by two helpers so that he can take hold of the bar with the palms of his hands outwards.

His chin must appear above the crossbar. The respondent must try to maintain this position for as long as possible. Only one attempt is allowed. The time is taken from the time he begins to hang until one of the following happens: his chin touches the cross-bar, his head is thrown back to keep the chin from touching the cross-bar or until his chin sinks below the level of the cross-bar. The time the respondent can hang is measured in minutes and seconds (Thomas & Nelson, 1985).

C) Anthropometric variables

Some anthropometric terms are subsequently discussed. The measuring-protocol as suggested by the International Group on Kinanthropometry (IGWK) is used in this study (Ross & Marfell-Jones, 1991)

1) Kinanthropometric terminology

1.1) The anatomical position

This is when the respondent stands up straight, arms by the side, palms and feet facing the front (Ross & Marfell-Jones, 1991).

1.2) The frankfort-level

When measuring the length of the body the head is held at the Frankfort level. The head is at the Frankfort level when there is a horizontal line from the orbital to the trachea. The orbital is the inferior edge of the eye-socket while the trachea is the indentation above the trachea of the ear (Ross & Marfell - Jones, 1991).

1.3) Vertex

When the head is held at the Frankfort level the vertex is the most superior point on the skull.

1.4) Acromial mark

When a person stands up straight with the arms relaxed by the sides, the acromial mark is the point on the superior lateral edge of the acromial.

1.5) Ilio-spinal mark

This mark is level with the inferior surface of the point of the anterior-superior spine of the ilium.

2) Variables, measuring- techniques and apparatus.

Subsequently the variables that are measured are discussed as well as the techniques and apparatus that are used. It is accepted that the kinanthropometrist is right-handed. The measuring protocol used is that prescribed by the IWGK (Ross & Marfell - Jones, 1991).

2.1) Body-mass

Apparatus: A verified electronic scale.

Method: The respondent is dressed in lightweight shorts. During the measuring, the respondent stands up straight with the weight spread over both feet. The respondent must stand still with the eyes ahead and the arms relaxed at the sides. The body weight is measured to the nearest 0,1 (one tenth) of a kilogram.

2.2) Skin-fold measurements

Apparatus: Harpenden skin-fold caliper with a constant pressure of 10 g/mm^2.

Method: The place where the skin-fold is to be measured is clearly identified and marked. A double layer of skin together with the subcutaneous fat in between is taken hold of firmly between the thumb and index-finger. This is exactly on the mark made. The skin fold is pulled away from the underlying muscle-tissue.

The mouth of the caliper is placed about 1 centimetre under the fingers and about one centimetre over the skin-fold. The caliper is held at the right angle and the trigger is released during the measurement. The skin-fold is held firmly during the measuring. During the measuring enough time is allowed for the skin-fold caliper to press firmly.

The reading is taken about 2-3 seconds after the caliper has been placed over the skin-fold because there is the possibility that the water contained in the sub cutaneous fat-tissue can be forced out. Two measurements are done per skin-fold and should there be a difference of more than 1 mm a third reading is taken.

The different measurements are taken in rotation to the other skin-fold measurements. All skin-fold measurements are taken to the nearest 0,2 (two-tenths) of a millimetre.

The various skin-folds measured are:

2.2.1) The triceps skinfold

A vertical skin-fold on the halfway mark between the acromional and radial marks on the posterior surface of the upper-arm.

2.2.2) Sub-scapular skin-fold

This skin-fold is measured directly under the inferior angle of the scapula in a lateral downward direction at an angle of 45° to the horizontal.

2.2.3) Supraspinal skin-fold

This skin-fold is measured about 7cm above the ilio-spinal mark on an imaginary line with the anterior edge of the armpit. The measurement is taken in a medial downwards direction at an angle of 45° to the horizontal.

2.2.4) Medial calf skin-fold

A vertical skin-fold on the medial part of the calf at the greatest circumference. The respondent bends the leg at a 90° angle and places the foot on a bench.

2.3) Circumference measurements

Apparatus: A flexible Holtain measuring-tape

Method: In the measurement of circumferences the measuring-tape is held in the right hand. The left hand is used to draw out the measuring-tape. The part of the body to be measured is encircled using the "hands-crossed" method where the left-hand crosses the right-hand during the placing of the tape. The measuring-tape is pulled tight but not so that it cuts into the skin. All circumferences are measured to the nearest 0,1 (one tenth) of a centimetre.

Subsequently, the circumferences measured are mentioned:

2.3.1) Upper-arm girth

The maximum girth of the upper-arm is measured while the arm is lifted in a horizontal position. The elbow-joint is brought to full function so that the upper-arm is maximally flexed. The respondent must make a fist.

2.3.2) Calf girth

The maximum circumference is measured while the respondent is standing upright. The legs are slightly apart and the weight is evenly spread over both feet.

2.4) Cross-section measurements

Apparatus: A Holtain-Anthropometer and leg caliper.

Method: The moving head of the stylus is held in the right hand while the stylus of the fixed end is held in the left hand. The styli are held by the thumb and the forefinger while the base of the anthropometer or leg-calliper rests on the arms. The middle-fingers are used to find the marks.

During measuring firm pressure against the bone is maintained. Flat styli are used for the cross-section measurements and are done to the nearest 0,1 (one tenth) of a centimetre. A discussion of cross-section measurements follows.

2.4.1) Humerus breadth

The greatest distance between the medial and lateral epicondyles of the humerus, while the arm is lifted at an angle of 90°, is measured. A leg-caliper is used with styli that point upwards. The marks are found with the middle finger and firm pressure is applied to the humerus.

2.4.2) Femur breadth

The greatest distance between the medial and lateral epicondyles of the femur are measured while the respondent sets down and the leg is bent at an angle of 90°. The leg-caliper is used with the styli pointing downwards. The marks are found with the middle finger and firm pressure is applied to the femur while measuring takes place.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1) INTRODUCTION

The goal of this study was to compare the results obtained when a set of variables obtained from certain test results were imputed into the discriminant analysis method, and then when this same set of variables were imputed into logistical regression. As was noted in the previous chapter, the method of discriminant analysis has traditionally been used as a sole basis of test result interpretation in South Africa. Logistical regression is in turn more commonly in use in the old East Bloc countries.

There are other equally effective methods however, with logistical regression being an example of such. Therefore, the need arose to examine the two, and to see what results were obtained by both, hence the origin of this study. Since the overall drive in South Africa is that of talent identification in general and in with particular focus on the previously disadvantaged populations, all the while remaining competitive in the international sporting arena, it is vitally important that all avenues be investigated, so as to ascertain whether we as a country are adopting and following the most effective options, all the while bearing in mind the time and money factors involved.

These variables were obtained by testing groups of under-11 rugby players that belonged to known groups of talent, i.e.: talented and less talented rugby players. A complete description of the test battery followed can be examined in chapter three. In this chapter, the descriptive statistics of the 2 groups will be examined in detail.

The results obtained from the tests done on the two groups will be examined, with a particular focus on the results obtained via discriminant analysis and logistical regression. The format will be predominantly in table form, with a written description that will follow.

4.2) COMPARISON OF DESCRIPTIVE STATISTICS OF THE 2 GROUPS

Before representing the table containing the raw data of the descriptive statistics obtained in the test battery that was followed, it is important to discuss these values. For the purposes of this explanation, the following values were observed and discussed and notated:

Table 2) Key explaining the symbols used in the notation of the findings of this study

VALUE OR OBSERVATION	NOTATION
1. Mean	$\bar{X}$
2. Standard deviation	S
3. Minimum and Maximum Value	Min and Max
4. d-value	d-value

The d-value represents the effect size, which is the standardised means difference between two groups that are compared to one another. It is a formula derived from the difference between the two means of the two groups in question, divided by the maximum standard deviation found in either of the groups in question. It is represented in the following way:

d value = (Mean 1 – Mean 2) ÷ Standard Deviation Max

OR, in notation it can be read as:

$$d = \frac{\bar{X}_1 - \bar{X}_2}{S_{max}}$$ (Steyn, 2000)

where:

$\bar{X}_1$ is the mean if the first group and $\bar{X}_2$ is the mean of the second group, and where S_{max} is representative of the maximum standard deviation that occurs between the two groups under evaluation.

An important note is the guidelines to interpret "effect sizes" or "practical significances." The guideline value for a small effect or significance is d = 0.2, for a medium effect or significance is d = 0.5, and for a large effect or significance is d = 0.8 (therefore practically significant, or of practical significance).

Note that d can be negative when $\bar{X}_1$ is smaller than $\bar{X}_2$, therefore the guidelines are for the absolute values of d (i.e. ignoring the sign).

What follows below is the table containing the raw data of the descriptive statistics obtained in the test battery that was followed. The X, S, min/max and d-values were observed and discussed and notated

Table 3) Descriptive statistics and significant differences of the SARFU and MSP groups with regards to rugby-specific skills, motor-physical abilities and anthropometrical data.

	MSP		n = 40		SARFU		n = 43		
VARIABLE	X	S	Min	Max	X	S	Min	Max	d-value
Body Mass (kg)	56.4	10.36	30.4	81.2	56	9.78	40.3	83.9	0.04
Triceps SF (mm)	21.6	6.75	8	32.4	9.6	4.8	4.4	22	1.8
Subscapular SF (mm)	22.72	10.92	6	43.6	8.98	3.89	5.5	23.4	1.26
Supra-spinal SF (mm)	25.4	12	4	46.6	8.74	8.53	4	51.1	1.39
Medial Calf SF (mm)	19.96	5.2	8	32.5	10.39	5.39	4.8	25.6	1.78
Upper Arm Girth (cm)	28.32	2.87	22	33.6	27.49	4.86	2.5	33	0.17
Calf Girth (cm)	34.38	2.97	27	42	33.34	2.92	28.9	41.5	0.35
Humerus Breadth (cm)	6.87	0.49	6	8.5	6.8	1.57	0.8	8.6	0.04
Femur Breadth (cm)	9.83	0.72	8.3	12	9.86	0.74	8.6	11.6	-0.04
Passing for Distance (m)	11.75	2.16	7.5	17	16.18	2.32	10.2	21	-1.91
Passing for Accuracy 7m (pts)	16.6	5.03	4	25	14.47	2.47	8	18	0.42
Passing for Accuracy 4m (pts)	2.47	1.9	0	7	3.83	2.2	0	7	-0.62
Running and Catching	14.79	4.85	0	20	18.83	1.54	14	20	-0.83
Kick for Distance (m)	23.78	5.58	10.3	33.4	30.52	5.12	19.8	43.5	-1.2
Kick-off for Distance (m)	22.89	5.73	10	32.4	32.54	7.42	17	45.5	-1.3
Speed (sec)	9.98	9.4	7	70	6.7	0.54	5.9	8.1	0.34
Flexed Armhang (sec)	22.53	14.44	1.4	68	43.3	20.36	0	83	-1.02
Vertical Jump (cm)	25.38	7.43	8	45	41.3	6.56	25	51	-2.14
Agility Run (sec)	8.26	2.82	0	11.9	7.11	0.45	6.3	8.1	0.41
Speed Endurance 1 (sec)	11.56	0.98	9.6	14.5	9.43	0.44	8.4	10.7	2.17
Speed Endurance 2 (sec)	11.67	0.98	9.6	14.4	9.59	0.55	8.8	11.2	1.1
Speed Endurance 3 (sec)	12.16	1.04	9.9	14.4	9.67	0.46	9	10.8	2.39
Speed Endurance 4 (sec)	11.73	2.79	0	15	9.68	0.45	8.9	11	0.73
Speed Endurance 5 (sec)	11.89	2.98	0	16.6	9.71	0.52	9	11.5	0.73
Speed Endurance 6 (sec)	11.43	2.8	0	16.3	9.65	0.47	8.9	11	0.64

d>0.8=Great Effect
d>0.5=Medium Effect
d>0.2=Small Effect (Hare, 1999)

4.2.1) Characteristics of Table 3

The characteristics and comparisons between the two groups will be discussed according to the following headings:

- Rugby-specific skills
- Motor-physical abilities
- Anthropometrical data

4.2.1.1) Sports-specific skills

In the above category, the SARFU group performs better in five out of the six tests (Table 3). The only test where the MSP group outdoes the SARFU group is in the forward pass for accuracy over 7m. When the significance or effect size is evaluated, it can be seen that that in all but 1 test, the SARFU group obtains a significance of 0.8 or higher, indicating a large significance.

The test that ranks as medium effect for the SARFU group is the forward pass for accuracy, in which they obtain an effect size or significance of –0.62. It is interesting to note that in the test in which the MSP performs better than the SARFU group, the effect size ranks as a small to medium effect, obtaining a d-value of 0.42. When the results of the above category are examined, certain realities boldly stand out.

As is known from previous discussions, the SARFU group is the "more talented" group. When this is considered, it can be seen that sports-specific skills rank highly in terms of distinguishing between the more talented and the less talented players, with extremely high significances in terms of the different skills that are needed to be successful in the game of rugby.

As a side note, this emphasizes the fact that skills need to be properly and exhaustively taught at an early age, for the proper effect to be seen at the same age, but more importantly later. For South Africa to remain competitive on the world stage, these skills need to be taught across the board, to all population groups, starting at a young age when the most important learning phases in terms of skills can and should take place.

4.2.1.2) Physical-motor abilities

As was mentioned in the discussion of the previous section (Table 3), it can be seen from the results obtained in this section that the SARFU group are indeed the more talented group, and it shows in the results obtained in the physical-motor abilities. SARFU outperformed the MSP group in all of the above tests.

When the d-values and therefore the significances are evaluated, the following is found:

There is a very high significance in five of the categories, namely flexed arm-hang, vertical jump, speed endurance 1, 2 and 3. The significance or d-value obtained is 1.02 or higher. There is a medium to high significance in three of the categories, namely speed endurance 4, 5 and 6, where the lowest d-value is 0.64. There are two categories in which the d-value is low, namely speed and agility run, where the d-values are 0.34 and 0.41 respectively, indicating a small to medium effect or significance.

What is significant from the results in this category is that SARFU outperforms MSP in all of the tests. This once again illustrates that the athletes have been sorted into the correct groups, but also that these skills or abilities are needed to be successful in the game of rugby, albeit that some skills are more significant than others.

The skills that appear, according to the test findings, to have more significance in terms of success are flexed arm-hang, vertical jump and the speed endurance tests. This does not necessarily mean that the others are not needed, but could indicate that they may not be as important as the above-mentioned skills.

This could emphasize that even at this young age certain motor-physical abilities need to be present, or at least visible or taught (trained). Therefore, a certain level of sports-specific training in terms of the above abilities would need to be performed. What should be noted, however, is that these are not necessarily abilities inherent in rugby only, but rather general skills trained to all participants in all sports.

4.2.1.3) Anthropometrical data

The results obtained in the above tests are more evenly mixed (Table 3), with SARFU outperforming MSP slightly. It is important however, that the results are carefully interpreted so as to get a true reflection of the situation that exists. Firstly, the skin fold results have been interpreted on that basis of the highest score not necessarily meaning the better result. Therefore, in theory the d-scores seem to benefit the MSP group in terms of size, but in reality it is most certainly not the case, and have therefore been interpreted for the benefit of the reader as being to the advantage of SARFU.

When the significances are further examined, it can once again be seen that where the MSP has outperformed the SARFU group the significances are very small, ranging from a d-score of 0.04 to 0.35. The variables are the following: body mass, upper arm girth, calf girth and humerus breadth. The variables in which SARFU performed better are the following: triceps, sub-scapular, supra spinal and medial calf skin folds along with femur breadth. The d-score for the femur breadth is an insignificant –0.04, but for the skin folds the range from d-scores 1.26 to 1.8 indicating very high significances.

When the raw data is examined, body mass, humerus and femur breadth can be interpreted as being of very little or even no significance in terms of determining success or failure in the game of rugby. When upper arm and calf girth are examined, where MSP outperformed SARFU the following can be assumed: the d-scores range from small to medium effect, indicating that in reality they have no effect on the game itself.

An interpretation is that MSP outperformed SARFU in these above two variables because of the fact that they had larger skin folds in (in those areas and overall) than SARFU. Excess underlying subcutaneous fat cannot be beneficial for success in rugby, and therefore can be regarded as insignificant.

When the skin fold results are examined, MSP had larger skin folds than SARFU, but as mentioned before, this is not a positive sign. The larger the skin fold, the larger the subcutaneous fat depositions, indicating a lower level of training and conditioning.

This is echoed in the physical motor ability tests, where SARFU outperformed MSP in all the tests.

Therefore, the overall interpretation of this author is that MSP are not at a physical standard, as measured by the anthropometrical tests, to compete with, and attain the level of success that the SARFU group have attained. It is evident that at this current stage of testing, the MSP are far from the level of SARFU.

4.3) DISCRIMINANT ANALYSIS

The process of discriminant analysis has already been fully described in chapter two. The two groups were compared to one another according to their predictive function. The results will be subsequently discussed. Before that discussion however, a look will be taken at the different factors that are the best discriminators.

The STEPDISC-Procedure of the SAS computer programme package (SAS Institute Inc., 1989:1493) was used to obtain the results in Table 4.

Table 4) Indications of best discriminating factors, using stepwise discriminant analysis

NUMBER	VARIABLE	PARTIAL R**2	F STATISTIC
1	Vertical Jump (cm)	0.5498	90.384
2	Tricep SF (mm)	0.2461	23.83
3	Mass (kg)	0.1675	14.491
4	Speed (sec)	0.0921	7.205
5	Speed Endurance (sec)	0.0899	6.918
6	Forward Pass (pts)	0.0756	5.64
7	Pass for Accuracy 7m (pts)	0.1041	7.901
8	Running & Catching (pts)	0.1537	12.169
9	Supra Spinal SF (mm)	0.059	4.142

The above table illustrates those factors have the best discriminating qualities with regards to the SARFU and MSP groups. When the table is examined, the following is clear:

1) Vertical jump is the best discriminator between the two groups. Then, in order of descending significance, you find that tricep skin fold discriminates second best followed by mass, speed, speed endurance, forward pass, pass for accuracy over 7m, running and catching and lastly supra spinal skin fold.

2) When the above factors are examined, the following can be seen:
   - 3 factors are sports-specific, namely forward pass, pass for accuracy 7m and running and catching;
   - 3 factors are motor-physical, namely vertical jump, speed and speed endurance; and
   - 3 factors are anthropometrical, namely tricep skin fold, mass and supra spinal skin fold.

These results are interesting, as it shows an equal distribution of factors that need to be taken into account when discussing talent and the prediction thereof. An overall view needs to be developed and maintained, as it is not really known what determines talent. In past discussions it was stated that all the factors need to be taken into account. The above table and its interpretation prove that point quite clearly.

4.3.1) Comparison of predictive functions of the two groups

The classification functions of the two groups were obtained by using the DISCRIM-Procedure of the SAS (SAS Institute Inc., 1989), using the selected factors from Table 4. The Coefficients for the functions are given in Table 5.

Table 5) Coefficients of classification functions of the SARFU and MSP groups

VARIABLE	GROUP	
	MSP	SARFU
	Less Talented	More Talented
Constant	-49.8491	-65.9543
Mass (kg)	0.54992	0.81921
Supra Spinal SF (mm)	-0.06393	-0.30555
Speed Endurance (sec)	0.57463	-0.08898
Vertical Jump (cm)	0.23838	0.5305
Pass for Accuracy 7m (pts)	0.8413	-0.19199
Speed (sec)	0.12807	-0.21251
Running & Catching (pts)	0.52455	1.51961
Humerus Breadth (cm)	3.67529	2.33513
Forward Pass (pts)	0.87915	1.70534

The classification function for a group is of the form:

$Y = A + B_1X_1 + B_2X_2 + \ldots + B_9X_9$ with A the constant coefficient and B_1 to B_9 the coefficients of the factors X_1 to X_9 as displayed in Table 5.

4.3.2) Cross-validation of the classification function of discriminant analysis

To determine the cross-validity of the two groups, each player's values for the nine factors were substituted into each of the two classification functions to obtain two values. A player was classified into the group corresponding to the largest of the two values (Rao, 1973). Table 6 gives the results of these classifications.

Table 6) Cross-validation of the categorised discriminant analysis

	Into Group: MSP	SARFU	TOTAL
Member from group: MSP	41	0	41
	100%	0	100%
SARFU	0	36	36
	0	100%	100%

When examining above table, it can be seen that both groups have been 100% correctly categorized according to discriminant analysis. Therefore, the method of discriminant analysis is 100% accurate in categorizing or sorting less talented from more talented individuals according to players used in this research.

4.4) LOGISTICAL REGRESSION

The formula that was applied to the results of the two groups, namely MSP and SARFU, to determine the possibility of the discriminating variables can be seen below:

$$P(X) = \frac{\exp (A + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4)}{1+ \exp (A + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4)}$$

After the whole process of logistical regression was completed, it was found that, where in the case of discriminant analysis where 9 variables were found to be accurate in predicting success, in logistical regression 4 variables were found to be acceptable variables in the analysis of maximum likelihood estimates. They are the following variables:

1) Calf SF
2) Pass for accuracy 7m
3) Running and catching
4) Speed

When these above variables are further analyzed, the following is found: there is also representation from each of the three categories of factors. Calf SF falls into the anthropometrical category and speed falls into the motor-physical category. Pass for accuracy 7m and running and catching both fall into the sport-specific category however.

Whether this possesses any significance will remain to be seen however. Each of the above variables had certain parameter estimates assigned to them during the course of the investigation. These parameter estimates are listed below:

1) Constant (A)	=	-46.4946
2) Calf SF (B_1)	=	-0.4302
3) Pass for accuracy 7m (B_2)	=	2.0211
4) Running and catching (B_3)	=	-3.0765
5) Speed (B_4)	=	9.7381

When these parameter estimates are substituted into the equation, you get the following model:

$$P(X) = \frac{\exp(-46.4946 - 0.43\,\text{calf SF} + 2.02\,\text{pass for acc. 7m} - 3.08\,\text{running and catching} + 9.74\,\text{speed})}{1 + \exp(-46.4946 - 0.43\,\text{calf SF} + 2.02\,\text{pass for acc. 7m} - 3.08\,\text{running and catching} + 9.74\,\text{speed})}$$

If the probability is high (> 0.5) then the player is categorized into the MSP group. If the probability is low (< 0.5) then the player is categorized into the SARFU group.

When the cross-validation is done on the categorizing into the two respective groups according to the probability function of logistical regression, the following can be seen:

Table 7) Cross-validation of the probability function of logistical regression

	Into Group: MSP	SARFU	TOTAL
From Group: MSP	41	0	41
	100%	0	100%
SARFU	0	35	35
	0	100%	100%

As can be seen from the above table, logistical regression is also successful in 100% categorization of the two groups. Therefore, the method of logistical regression is 100% accurate in categorizing or sorting less talented from more talented individuals.

As stated at the beginning of this study, one of the stated aims was to determine which of the above two methods were more accurate in predicting or discriminating the more from the less successful individuals. As can be seen from the above results, both methods are equally accurate in predicting success.

Since that has been determined, the next stated aim was to determine if you could have a more accurate method if the two methods were combined. As was mentioned previously in this chapter, the discriminant analysis method has nine variables that discriminate better than the rest, whereas logistical regression has four. For recap purposes these factors will be listed below

Table 8) Table listing factors found to be best determinants of success in both predictive function methods

Discriminant Analysis Factor	Match	No Match	Logistical Regression Factor
Pass for Accuracy 7m (pts)	√		Pass for Accuracy 7m
Speed (sec)	√		Speed
Running & Catching (pts)	√		Running & Catching
Supra Spinal SF (mm)		X	Calf SF
Speed Endurance (sec)		X	N/A
Vertical Jump (cm)		X	N/A
Humerus Breadth (cm)		X	N/A
Forward Pass (pts)		X	N/A
Mass (kg)		X	N/A

What can be seen is that three factors or variables correspond in both methods. These are the pass for accuracy 7m, speed and running & catching. Pass for accuracy 7m and running & catching fall into sport-specific category, whereas the speed falls into the motor-physical category. A discussion of the significance of this will follow in chapter five.

A further step was taken, whereby the four factors found to be successful determinants in the logistical regression method were substituted into the discriminant analysis method. The factors were pass for accuracy 7m, calf SF, running & catching and speed. The following was found, and is illustrated in the table below:

Table 9) Table illustrating results obtained when logistical regression factors are substituted into discriminant analysis method

	Into Group: MSP	SARFU	TOTAL
From Group: MSP	40 93%	3 6.98%	43 100%
SARFU	5 13.89%	31 86%	36 100%
TOTAL	45 56.96%	34 43.04%	79 100%

From the above it can be seen that when those four factors are substituted into the discriminant analysis method, results are obtained that are less than 100% prediction accuracy. In the above scenario, there is a 93% prediction accuracy with the MSP group, whereas there is a 86% prediction accuracy where the SARFU group is concerned. The significance of the findings reported in the above table will also once again be discussed in chapter five.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1) SUMMARY

A short summary will be presented of the course that this study has followed, as discussed in the preceding chapters. The most important conclusions of this study will be presented and discussed, followed by recommendations that will flow from these discussions.

As has been mentioned numerous times in this study before, South Africa has a proud sporting tradition, with an excellent if not enviable record. Even our post-isolationist sporting record is impressive, with victories against all our traditional "foes", including probably our proudest moment, winning the Rugby World Cup in 1995 and in so doing becoming the world champions.

Other note worthy achievements have been winning the African Cup of Nations Football Championships in 1996 and reaching the semi-finals of the 1999 Cricket World Cup, as well as the semi-finals of the 1999 Rugby World Cup in the same year. Certain other performances cannot be forgotten, namely when we think of certain of our achievements at the Olympic games in the 10 000m ladies race, the men's doubles tennis, the marathon for men and our swimmers and not to mention our golfers who do us so proud. We are also highly competitive with hockey and netball.

The point cannot be argued more convincingly that we have strong representation in international competitions. What needs to be remembered however is that, as a proud nation with a proud record, we would love to continue in the same vain. It is this author's opinion that we need not worry about our pools of talent in the above-mentioned sports types, as the talent is present, albeit in an unidentified, unnoticed, undetected or undeveloped form.

What this does emphasize however is that this talent needs to be identified, noticed, detected and when all of this is done, developed and nurtured. It has been discussed at length in not only this study, but numerous others that once talent is identified, it needs to be developed and maintained and encouraged to flourish and reach it's fullest potential.

According to Hare (1999) we are in competitive sport world, and that when participating in this competitive sport world that there is already a search for potential champions at a young age. According to Bloomfield (1994) it is this reason that necessitates the identification of talent at a young or early age. In the last two decades of the previous century, the East Bloc countries in particular achieved good results when it came to the terrain of talent identification following scientific methods amongst young children (Du Randt & Headley, 1993).

According to Salmela & Règnier (1983) talent identification is a long-term process whereby potential sports participants are identified in a particular sports type and then developed further. As argued above, South Africa needs to remain competitive in the international sports arena, and in so doing we need to remain up to date on the latest techniques and technologies regarding talent identification.

The country realized, upon readmission into the international fold, that the isolation we experienced was a major factor in our falling behind regarding the scientific methods used in talent identification by the rest of the world. It seems obvious that for future talent, a look needs to be taken at today's youngsters, those who are already showing promising signs of talent, and even those who may not yet be showing these signs of talent but could still have potential to reach the top.

As an addendum, however, it must be stated that the influence and effect of growth, development and maturation need to be considered as this can influence the achievement of sports participants (Hare, 1999).

As mentioned in the previous paragraph, there may be some participants who may, as of yet not be showing any overt signs of talent, but who may have latent talent that will come to the fore only later in the participant's life.

When the structure of this study is reviewed, the following will be found: chapter one contains the introduction and brief overview of what is to follow in the subsequent chapters. What is mentioned however, is the focus and goal as well as the hypothesis of this study, and this is worth revisiting. It consists of the following:

The focus of this study is to use existing data concerning 12 year-old rugby players. Discriminant analysis has been done on the sample group, with specific results obtained. Logistical regression is then done to determine if the tests needed for this method differ from those obtained in discriminant analysis.

The goal of this study is to perform a statistical comparison between discriminant analysis and logistical regression regarding the development of prediction function by using existing data concerning 12 year-old rugby players. Discriminant analysis has been done on the sample group, with specific results obtained.

Logistical regression was then performed on the same sample group to determine if the collective predictive functions differ in terms of talented and less talented players. A comparison was then made with the results discussed regarding the benefits of the two methods and the approach needed by coaches, researchers and the sporting authorities in this country.

The hypothesis of this study is that there is a difference between the results obtained by the discriminant analysis and logistical regression methods regarding the prediction of talent and the establishing of prediction functions.

Further questions that were asked were:

- If there are differences in the result obtained by the two methods, are these differences significant?
- Can these differences in the findings of the two methods, if any, mean the difference between success and failure or the overlooking of a talented player in favor of a less talented player?
- Is there a way to combine these two methods to form a more accurate method?
- Could this study perhaps help South Africa in the current situation that we find ourselves regarding the identification of talent in the previously disadvantaged communities?

Chapter two consisted of an in-depth literature review, not just in terms of existing literature on this subject, but also a review of the respective predictive methods that formed an integral part of this study. Conclusions regarding the above methods will also be discussed in the following pages.

Chapter three reviewed the empirical investigation followed in this study. Each test was completely explained in terms of apparatus used and methods followed. Chapter four was a review of the results and a discussion of the results. While this chapter will be discussing certain key/core issues, for a more in depth discussion a review of chapter four will suffice.

5.2) CONCLUSIONS

The conclusions of this study are formulated mainly according to the hypothesis, with further conclusions drawn from further questions asked and answered by this study.

The finding of this study is there are no significant differences found with the results obtained by using discriminant analysis and logistical regression as methods of predictive function. This conclusion rests on the findings as illustrated in tables seven and eight of chapter four. Each method has a 100% accuracy in predicting or distinguishing between more and less talented players. Based on this it would then be up to the discrimination of the researcher(s) as to which method would be used.

This result then therefore nullifies question one and two of the further questions that follow, namely that if there are differences in the result obtained by the two methods, if these differences significant and secondly if the differences in the findings of the two methods, if any, mean the difference between success and failure or the overlooking of a talented player in favor of a less talented player?

Another question raised was if the two methods could be combined to form a more accurate method. Before this question is answered, a more in-depth review of the above findings is needed. Although there is no difference in the results obtained by the two methods, it stands to reason that there will be fundamental differences in the two methods themselves.

Firstly, when discriminant analysis is analyzed, it can be seen that this method uses more variables to discriminate the more talented from the less talented, a total of nine variables. The logistical regression method only used four variables. For a full review of the variables in question, refer to table four in chapter four.

What becomes apparent however, is that of the different variables in question, there were three that corresponded. When the four variables used in logistical regression were substituted into the discriminant analysis, it was found to predict less accurately than 100%. Refer to table nine in chapter four for a review of the findings of these substitutions.

What is clear in this case is that, instead of combining the two methods, a few options can be considered, determinant of certain factors. Firstly, an "either-or" approach can

be followed, as each method predicts equally accurately. When a clear indication of the more discriminating factors is needed, discriminant analysis should be used. When the relative impacts of the different factors are needed, then logistical regression is the most obvious choice of prediction.

Each of the above options obviously has it's own advantages and disadvantages. When merely wanting to determine or detect the presence of talent, discriminant analysis may be the better option to take. When doing a more in-depth study of talent and its effects or impacts, logistical regression may be the better option.

The last question was whether this study could be of benefit in the arena of talent identification in the previously disadvantaged areas. The answer to this is an emphatic yes! When it is known what is being looked for, and even when general talent identification is needed, then the above two methods can most definitely be of benefit to this need.

It is imperative that this issue be addressed as soon as possible, not only to predict further talent and to develop it, but also to still remain competitive with the current crop of participants while still addressing this issue in an effective and fair way. While it may be true that a drop in achievement or performance may be unavoidable, it is not the desirable and may even be detrimental to this country's sport, not necessarily in the long term, but certainly in the short to medium term. This does have negative effects, and should be avoided if at all possible.

When looking to whether the hypothesis of this study has been proven, it is fair to say that this study has proven that there are no differences in the findings of the methods in question, but that there are fundamental differences in the methods themselves, due to the statistical make-up of these methods. Therefore, the answer is no, the hypothesis has not been proven in this case.

When examined on the whole, this does not have negative consequences, but in fact can be a major advantage. Regardless of the method or model that is chosen, there is

still the ultimate "safety net" of knowing that eventually the same results regarding talent or lack of it will be attained. As mentioned before, each of these methods have their own advantages and disadvantages, and the testers, coaches and all interested parties need to evaluate these advantages and disadvantages before commencing with testing. The particular functions of either method can be of benefit to the above-mentioned interest groups.

What needs to be seriously considered is a combination of the two methods when testing for talent. In so doing, a thorough evaluation of the individuals and the factors influencing the decision as to whether they possess talent or not will be made, and the researchers as well as participants can be rest assured that all the factors have been exhaustively evaluated.

This study is also clear in its statements when it says that South Africa is still behind in the field of talent identification, but that we are catching up. This is encouraging as it means that it is a situation that is improving. While the situation is improving it means that it is to the benefit of the whole country. In righting the wrongs of the past, and in so doing expanding our participant and talent base, the ultimate unity of the country will hopefully follow, as witnessed in the Rugby World Cup 1995 and the African Cup of Nations soccer in 1996 when the whole country forgot their differences and supported their team as one.

It is the desire of all South Africans, with our proud sporting history and known ability, to unite behind fully representative and competitive teams and to eventually relive past glories and ensure that they become our present and future glories as well.

5.3) RECOMMENDATIONS

Out of the above conclusions and the study as a whole, the following recommendations can be made:

5.3.1) Since there is, contrary to what was proposed by the hypothesis, no difference in the results obtained by the two methods, a midway needs to be found. Rather than adopting a preference for the one method at the expense of the other method, the following recommendation is made:

For a proper, thorough and in-depth talent identification process to be followed, it is recommended that both methods, i.e.: discriminant analysis and logistical regression be performed on the groups in question. The reason for this is that both methods have their relative advantages, disadvantages and focus areas inherent in their designs. It will be better that both be used so as to get the full spectrum of talent that is being identified.

5.3.2) To further expand on 5.3.1, the following needs to be noted. When the study is examined, it leads to the conclusion that there are differences in focus or emphasis of the methods in question. While discriminant analysis tends to differentiate the factors that discriminate the best, logistical regression tends to focus on the relative impact of the factors that are being measured. Both these methods have a very definite role to play with regards to the identification of talent in the previously disadvantaged communities, and talent in general. A possible recommendation is the following:

The above idea is best illustrated by using a hypothetical example: when a researcher is in the field, testing raw talent, discriminant analysis may be the better method to use. The reasoning behind this statement is contained in the above paragraph, namely that this method better differentiates the best discriminating factors. Once an idea has been formed as to those who possess the sought after talent, logistical regression can be applied to determine their

relative impacts as well as to confirm the findings of discriminant analysis.

Therefore, once the time has arrived to implement the application of the methods under discussion, this application can consist of two phases. The initial phase can be implementation of the method of discriminant analysis, while the final phase can be the implementation of the method of logistical regression.

5.3.3) While this study has been done on rugby players, it is feasible to suggest and therefore recommended that these methods be applied to other sports types. It is in the interests of this country that a vigorous talent identification process be launched, for now and the future. These methods can be of importance in aiding this process.

5.3.4) While it has been mentioned before, it is worthwhile to note again and is strongly recommended that responsibility be taken by the different role players in talent identification and prediction to nurture the talent that has been identified to the point of full maturation and potential. Utmost care needs to be taken in guiding the youngsters in their chosen direction, and never to lose sight of the fact that they are human beings and not merely assets available to them to make money with and to uphold national pride.

It is also therefore recommended (as has been mentioned in this study) that those who have been identified as not possessing talent in their chosen field be responsibly guided as quickly as possible in a direction in which they have more of an aptitude. Disappointment is inevitable, but can be valuable as a tool in mobilizing these individuals to pursue activities and sports types to which they are more suited.

What is implicit in this recommendation is that a database needs to be established in which tests and results for various sports types related or otherwise, are contained for reference and guidance purposes in the eventuality that an individual is found to not be suited for a particular sports type in which they have an interest or are pursuing.

5.3.5) It is also recommended that more studies be done on this topic, as it will be beneficial to this country and to the general pool of knowledge regarding this field. Sport is a highly competitive field, and to get the best results, the talent needed to be competitive in this sport needs to be uncovered at increasingly early ages. It is ultimately to the advantage of not only the country, but also the individual.

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