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# DESIGNING A PROTOCOL AND COMPARATIVE NORMS FOR THE IDENTIFICATION AND SELECTION OF TALENT AMONG ELITE AGE-GROUP RUGBY PLAYERS IN SOUTH AFRICA

by


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**submitted in partial fulfilment of the requirements for the degree**

**DOCTOR PHILOSOPHIAE**

in the


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## DEDICATION

This work is dedicated to my Lord and Saviour and my two girls; Chantél my wife and Zoey my daughter.

Without you in my life, I am nothing and I amount to nothing.

Thank you!

## ACKNOWLEDGEMENTS

I would like to take the opportunity to thank the following individuals and groups for standing by me and assisting me in the successful completion of this study.

To My Lord and Saviour Jesus Christ: You came into my life at a young age and have been there ever since. I have made mistakes and you have picked me up. I have needed help and you've been there. But, above all else I would like to thank you for dying for me on the cross and for choosing me to be your servant. It is my aim in life to glorify you and to let you shine. You are my Alpha and Omega, my beginning and my end.

To Chantél and Zoey: My two girls. You have brought unending joy and happiness into my life and I thank the Lord every day for blessing me with you both. Chantél, you're everything I could ever have asked for and more. Thank you for standing by me in this study and for always believing in me. Zoey, you entered into our lives during the course of this study and we thank the Lord for you daily. You are such a blessing to us and have made us so happy. May we successfully raise you in the ways of the Lord so that you honour and glorify Him with your life and your all. I love you both so much!

To my Parents: Mom and Dad, your example has been of immeasurable value to me in my life. Your humility, your years of humble service in the ministry to the King, and your endless sacrifices for me and Anton have meant so much to us. This example and experience is engraved upon our hearts forever. Thank you for always believing in me; you made me believe in myself! I love you.

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**Philippians 1:6:** *“And I am convinced and sure of this very thing, that He Who began a good work in you will continue until the day of Jesus Christ [right up to the time of His return], developing [that good work] and perfecting and bringing it to full completion in you.” (AMP)*

# SUMMARY

| | |
|---|---|
| **TITLE** | Designing a protocol and comparative norms for the identification and selection of talent among elite age-group rugby players in South Africa |
| **CANDIDATE** | Conrad Booysen |
| **SUPERVISOR** | Prof. P.E. Krüger |
| **DEPARTMENT** | Biokinetics, Sport and Leisure Sciences |
| **DEGREE** | D.Phil |

Talent identification and the subsequent development of those individuals with the most potential to succeed is currently of great concern for sporting bodies in a number of countries and South Africa is no exception. Sport in South Africa holds a position of great prominence and has been used in many instances to facilitate national unity and pride.

Rugby Union is one of the most prominent sports in South Africa and it is in this sport that South Africa has achieved a great measure of success, both historically and currently. It is a sport in which the future sustainability of this success is high on the agenda. There have been a number of studies on talent identification in rugby and this study aims to contribute to that body of knowledge. To achieve this contribution, this study has two primary goals and aims.

This study has as its primary goals and aims: 1) to have a sound theoretical base provided by in-depth and up to date research that will form the foundation for, 2) reviewed and alternative sport and position-specific testing protocols as well as comparative results consisting of norms and scores that will adequately identify and select those capable of participating in elite age-group rugby union.

Contained in the theoretical base of this study is a review of the physical parameters required to succeed in sport, a discussion of the nature vs. nurture debate and a review of the developmental approaches to talent and ability. Other factors such as psychological skills, abilities and attributes and a historical review of talent identification models and approaches world-wide as well as in South Africa have also been provided. In all, the first primary aim and goal of this study has therefore successfully been achieved.

Thereafter, the reviewed and alternative test protocol has been presented, discussed and executed, followed by an analysis of the results obtained. Specific achievements of this study are that new and modified tests (3x5x22m Anaerobic capacity test, S-Test and the Kick-for-distance and accuracy test) for talent have been developed and that specific scores and norms for these new tests, as well as other pre-existing tests, have been established for future reference. In noting the success of the alternative, broad-position specific protocol and the establishment of scores and norms, the second primary goal and aim of this study can be said to be achieved. This study then ends with conclusions and further proposed recommendations.

It can therefore be concluded with a great amount of certainty that this study has been successful not only in presenting as up to date research as possible in the fields of excellence and elite sport, but that furthermore, this study has provided a robust test protocol with comparative norms that can be used as an alternative identification and selection tool.

Key words:

| | |
|---|---|
| rugby | sustainability |
| talent | physical parameters |
| identification | psychological skills, abilities and attributes |
| selection | historical approaches |
| protocol | comparative norms |

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## OPSOMMING

| | |
|---|---|
| **TITEL** | Die ontwerp van 'n protokol en vergelykende norms vir die identifisering en seleksie van talent in elite ouderdoms-groep rugby spelers in Suid Afrika. |
| **KANDIDAAT** | Conrad Booysen |
| **PROMOTOR** | Prof. P.E. Krüger |
| **DEPARTEMENT** | Biokinetika, Sport and Vryetydwetenskappe. |
| **GRAAD** | D.Phil |

Talent identifisering en die daaropvolgende ontwikkeling van daardie individue met die meeste potensiaal is huidiglik van groot belang vir sportliggame in talle lande. Suid Afrika is geen uitsondering nie. Sport in Suid Afrika is in 'n posisie van groot prominensie en was al gebruik in baie gevalle om nasionale eenheid en trots te bewerkstellig.

Rugby is een van die mees prominente sportsoorte in Suid Afrika, en dit is in hierdie sport dat Suid Afrika groot suksesse behaal het, beide histories gesproke en huidiglik. Dit is 'n sport waarin die toekomstige handhawing van hierdie sukses hoog op die agenda is. Daar was al 'n aantal studies met betrekking tot talent identifisering in rugby en hierdie studie beoog om 'n bydrae maak tot daardie kennis. Om hierdie bydrae to maak het hierdie studie twee doelwitte en oogmerke.

Die twee primêre doelwitte is: 1) om 'n grondige teoretiese basis te skep deur deurtastende en kontemporêre navorsing wat grondliggend sal wees vir, 2) oorsigtelike en alternatiewe sport en posisie-spesifieke toetsprotokolle wat daardie individue genoegsaam sal identifiseer wat die nodige vaardighede en karaktertrekke het vir elite ouderdomsgroeprugby.

Bevat in die teoretiese basis van hierdie studie is 'n oorsig van die fisiese paradigmas nodig vir sukses in sport, 'n bespreking van die "aard vs. opvoeding" debat en 'n oorsig van die ontwikkelings benaderings tot talent en vaardighede. Bykomende faktore soos sielkundige vaardighede, vermoëns en karaktertrekke en 'n historiese oorsig van talent identifisering's modelle en benaderings oor die wêreld sowel as in Suid Afrika word bespreek. Dus is die eerste primêre doelwit van hierdie studie suksesvol behaal.

Daarna word die alternatiewe toets protokol aangebied, bespreek en uitgevoer, gevolg deur 'n analise van die resultate wat behaal is. Spesifieke prestasies van hierdie studie is dat nuwe en gemodifiseerde toetse (3x5x22m Anaerobiese kapasiteitstoets, S-Toets en die Skop-vir-afstand en akkuraatheidstoets) vir talent ontwikkel is en dat spesifieke tellings en norms vir die nuwe toetse en ander voorafgaande toetse vir toekomstige gebruik opgestel is. As gevolg van die sukses van die alternatiewe, breë posisie-spesifieke protokol sowel as die opstelling van tellings en norms, is die tweede primêre doelwit vir hierdie studie ook suksesvol behaal. Daarna volg die gevolgtrekkinge en verdere aanbevelinge vanuit hierdie studie.

Daar kan met groot sekerheid gesê word dat hierdie studie geslaagd is in die aanbieding van navorsing so op datum as moontlik in die gebiede van uitnemendheid en elite sport, maar dat hierdie studie 'n robuuste toets protokol aanbied met vergelykende norms wat gebruik kan word as 'n alternatiewelike identifiserings en seleksie werktuig.

Sleutel woorde:

| | |
|---|---|
| rugby | volgehoudendheid |
| talent | fisiese parameters |
| identifisering | sielkundige vaardighede, vermoëns, karaktertrekke |
| keuring | historiese benaderings |
| protokol | vergelykende norms |

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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'"* (Booysen, 2002:1).

Starkes (2003:4) concurs with the above sentiments when saying that *"Sport is unlike most human endeavours. It inspires poets and artists while it energizes armchair coaches and critics."* Starkes (2003:4) then emphasises the fact that *"Sport is so prevalent and so much part of our everyday lives that we take for granted the years of necessary preparation that underlie every great sporting feat."*

*"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"* (Booysen, 2002:1). It goes without saying that sport as a mass-market product and as an industry generates vast sums of money, but it is also further a target for equally vast sums of money in the form of sponsorship and investment.

Sport as a commodity has grown incrementally in South Africa and the world over. In referring to estimates from the Associated Press back in 1991, Stotlar (1993) says that in the United States of America, sport is a massive concern that falls within the top 25 largest industries in that country and is worth approximately $180 billion. If this was the case in the early 1990's, one can only imagine what the scenario is like today, more than a decade and a half later.

While South Africa's sport industry pales in comparison to America's, primarily due to the comparative market sizes of the respective countries, it is no secret that sport is a major industry in South Africa. Millions, if not billions, of rands are spent on sponsorships, endorsements and the like, and so it is fair to say that a number of industries in South Africa, whether tied to sport however tenuously or not, see the value of associating their brands and services with the image of sport.

According to Koenderman (2007), the total amount spent on sport sponsorship in South Africa in 2006, including the outlay spent on leveraging this sponsorship, exceeded R4.8bn. This amount was an increase of 18.5% on that spent in 2005. These figures are confirmed by the Beeld Newspaper (19 April 2007:30) who state that according to the latest figures of 2006, R2.6bn was spent on actual sponsorship with an extra 85c for every rand of this sponsorship investment spent on further leveraging the sponsorship.

This increase in sponsorship expenditure mirrors trends across the world; in 2002, more than two thirds of the $26 billion dollars spent on sponsorship worldwide was spent on sport (Crompton, 2004). According to Ali *et al.* (2006), the worldwide spend on sponsoring sport and related events in 2004 amounted to $28 billion with the accompanying leveraging costs adding up to 70% more to this amount. In the United States of America alone, the total amount spent on sponsorship increased to $8.5 billion in 2002, from an initial $850 million in 1985 (Maher *et al*., 2006).

In 1998 cigarette companies in America spent $125.6 million on sponsoring sports and events. Up to 70% of the amount spent by tobacco companies on sponsoring sport is dedicated to motor sports, although growth in these figures will undoubtedly be affected by the sponsorship limitations placed upon the tobacco companies that came into effect in November 2001 (Siegel, 2001).

Sponsorship and endorsements are not the only avenues of revenue spend in the industry of sport. When the total money spent by sport participants, enthusiasts, viewers as well as the sponsors and endorsers is tallied, the total amount is staggering. It is therefore for good reason then that those who spend money on sport for whatever purpose usually demand a satisfactory return on their investment.

Sport has seemingly become a commodity from which satisfactory results are a pre-requisite. This commoditisation of sport has had some fairly obvious results. The laid back approach to sport adopted in the past are well and truly behind us, with this point so eloquently highlighted by Cooke (2004:19) who, when describing the Australian sporting context, states that *"During most of the history of organised sport, recruitment was a matter of putting a notice on school bulletin boards, or placing an advertisement in the local newspaper, and waiting to see who showed up."* Cooke (2004:19) goes on to say further that *"…by the mid-1970s, it was becoming clear this was not enough and that reform, enabling sports to make the best of the nations' limited potential, was essential."*

Cooke's (2004) feelings regarding the maximising of limited potential dovetail Morris' (2000) outlook that sporting organisations are all seeking a competitive advantage over one another, with talent identification viewed as being able to contribute to furthering this advantage. Talent identification is also seen as a crucial element in the running of elite athlete programs (Hoare, 1998). And, the establishment of elite academies is also on the increase (Williams & Richardson, 2006; Button & Abbott, 2007), with these academies having as their aim the development and identification of future elite athletes to ensure sustainability. Therefore, sustained top performance and financial concerns are a reality faced by those participating in the sports industry.

In developing these stars of the future, it is apparent that certain major role-players are involved in this process. Significant others, such as parents and coaches, play an important role in the sustained participation of children in sport (Bloom, 1985; Côté, 1999; Williams & Richardson, 2006). Studies mentioning the specific role of mothers (Papaioannou *et al.,* in press) and fathers (Jodl *et al.,* 2001) in influencing sport participation in children can be found. The interaction between the coach and athlete has also been further studied (Jowett & Cockerill, 2003; Philippe & Seiler, 2006), as has the influence of peers (Papaioannou *et al.,* in press). The impact of role players such as parents and family (Burnett, 2005) and the trainer and coach (De Villiers & Le Roux, 2005) in the development of elite athletes from a uniquely South African perspective has also been investigated.

But, an increased focus on excellence and performance does have a down side. Mitchell (2004:64) opines that *"Serious competition in almost any sporting discipline can quickly transform a pastime into work, and play into routine."* It has further been found that the (over) involvement of parents in their children's sporting careers can be detrimental to children and their participation in sport (Gould *et al.,* 2006).

It is also not always clear whether this evolution of sport to its currently held concept is a good or a bad thing. There is nothing wrong with participating in sport to make a living or to make good money, but, where does this pursuit end, or worse, begin? The desire for professionalism in school and amateur sport and the possible associative dangers inherent in such a desire are apparent. Some honest questions need to be asked: is school and amateur sport the new semi-professional environment? What about the oft-heard statement that the amateur leagues are the feeders of the professional leagues? Sport seems to be morphing into an environment where the true concept and meaning of the term amateur as this term was originally intended, is in today's milieu well and truly a state where the amateur participants are real "no hopers;" regarded as the dross of the sporting world.

It is interesting, though, that not everyone participates in sport solely for the tangible or financial rewards associated therewith. In a recent South African study aimed at investigating the reasons that motivate high school pupils to participate in sport, some pertinent factors were identified. These factors were identified as being those of *"…adventure/pleasure, recognition/achievement, team spirit/affiliation, ability/physical appearance, competition/challenges and energy release"* (Coetzee *et* *al.,* 2005:51). While certain competitive and prestige elements were evident in this study, the overall balance and mix seems to be quite even. This balance is rather encouraging when examined against the greater South African sporting landscape of high value and price attached to school and amateur sport.

From the literature it is evident that talent identification is a prominent topic of investigation worldwide, and for some time now. Helsen *et al.* (2000:728) make note of the fact that *"The search for specific talents that underlie certain sport or movement skills is not a new idea."* This is largely confirmed by Papadopoulis *et al.* (2006:239) who state that over the course of a number of years, the *"…programs of talent identification have been applied from an early age, in countries when diagnosis, control, and guidance are used to promote athletes to high-level sports."*

Within the particular South African context, this country is known for its incredibly competitive attitude worldwide. This "never say die" attitude is unfortunately not enough to consistently guarantee or ensure success in the sport arena. Fortunately this was realised early enough, and in 1992 du Randt made a major contribution to talent identification in South Africa. A number of studies have followed since then, adding to the wealth of local knowledge on this subject in South Africa. This study aims to add to the wealth of knowledge of talent identification in South Africa by reviewing and developing an alternative testing protocol for elite rugby in South Africa that is relevant, reliable and effective.

To further increase South Africa's pool of knowledge in a constructive and meaningful way, accurate methods of talent identification and development need to be developed. Abbott and Collins (2004) make their own sentiments known in this regard by saying that the requirements for accurate and reliable methods for identifying and developing talent in sport are a priority. Reliability, and for that matter relevancy, are not without their own unique challenges however.

Hyllegard (2005:362), in citing Lehmann (1998), states that *"…the performance required to be considered talented in many domains continually changes as individuals exceed past performances."* In quoting Schulz and Curnow (1998), Hyllegard (2005:362) further says that *"Sports history has shown that World and Olympic records are commonly broken and that remarkable performances from the past are eventually equalled or surpassed by any number of individuals."* It only stands to reason then that this continually improving achievement in sport presents a challenge to talent identification as well, and further creates a need to continuously review and update South African based norms and standards, with this being suggested by du Randt and Headley (1992d) in the early 1990's already. In achieving this goal, all avenues followed in the identification of talent need to be as scientifically based as possible. The days of relying on gut instinct, or to the more cynical of souls, the like or dislike of individuals by the coach involved, are over.

With all the science involved in talent identification, however, the human element so critical to sport can often be overlooked. Previously in this chapter it has been acknowledged that people participate in sport for many diverse reasons and these reasons need to be acknowledged and respected. Also, with the history of this country still playing a role in current day progress and achievement, one would do well to bear all this in mind when considering the preferred approach for the unique South African circumstances.

South Africa's history should be seen as a challenge and not an insurmountable obstacle. It would be all too easy or tempting to use this country's history as an excuse to be less scientific in the approach to talent identification in sport. Our history may in fact lead to South Africa succumbing to the temptation of foregoing scientific excellence in order to correct the injustices of the past, with the consequent lack of quality in approach and outcome. No one disputes that these injustices need addressing; South Africa as a whole and South African sport in particular will be much richer for it. But, a delicate balance needs to be maintained.

From reviewing the literature, the following factors are clear: 1) sport has evolved and is still undergoing change; 2) with this evolution has come the inevitable financial investment in sport and related matters; 3) people participate in sport for a variety of reasons; 4) there are many role-players in the development of talent, and; 5) within the South African context, advancement in research on talent identification and development, while satisfactory, needs to improve.

In the end, however, it must be remembered that often organised sport is seen as a business; a business that has a massive financial turnover and a business where success and failure are probably more painfully obvious and public than many other industries and sectors. Therefore, success and the sustainability of success are primary motivators and drivers of this unique industry. This serves to further underscore the need for scientific methods to detect, identify and measure talent and top performance in sport.

In conclusion of this section; while sport is a consideration in this study, the specific focus and application of this study is rugby, with particular reference to (age-group level) elite rugby. South Africa is widely regarded as being one of the so-called powerhouses or “Big Five” (sometimes also referred to as the Big Six when including Ireland) in world rugby and this status needs to be maintained. South Africa is a proud rugby playing nation and anything less than excellence cannot and should not be tolerated. This study aims to contribute to rugby in South Africa as a whole.

## 1.2 STATEMENT OF PROBLEM

Rugby is a dynamic sport that is played in a constantly changing environment. It is difficult to predict the exact circumstances in which players might find themselves within the context of an 80-minute game. In fact, sport as a whole is a phenomenon where the specific circumstances are difficult to pre-determine or even simulate. There are a number of inherent features to sport that makes this study area unique (Hodges *et al.,* 2006), but, these self same features can make the study of excellence in sport a challenging issue.

Besides this challenge, the issue of accurate and reliable talent identification models and methods are high on the agenda, as touched on briefly in the previous section. Most countries that compete in the international arena are seeking for ways to accurately identify, predict and assess talent (Martindale *et al.,* 2005). But, this is difficult. Brown (2001: vii) states that *"Sports talent often depends on the eyes of the beholder. Millions of parents and thousands of youth coaches see their star athletes on a can't-miss path to full scholarships at major universities or even to careers in professional sports."* Brown (2001: vii) goes on further to say: *"In the eyes of trained coaches, recruiters, and scouts, however, sports talent is more difficult to assess. People who make a living recognizing and developing athletic ability understand that the potential to excel is sports depends on a combination of physical, environmental, mental and emotional factors. Talent, even when present and accounted for, does not guarantee athletic excellence."*

*"Traditionally, TI models have measured children on physical and performance variables that are perceived to be a requisite for success within a given sport"* (Abbott & Collins, 2002:158). But, research performed on children and adolescents with the express aim of predicting future success has been found wanting, with Vaeyens *et al.* (submitted) providing examples of the short comings of talent identification approaches that rely only on physical, technical, physiological and anthropometric variables. The critique of these methods is also shared by Abbott and Collins (2002:159) who say that *"The continued dominance enjoyed by physical and performance TI models in Eastern Europe, and their transfer to Western countries (e.g. Australia's Talent Search programme and the Scottish Sport Interactive programme), is particularly surprising since their inability to predict the future performance capacity of an individual was presented more than 30 years ago (Kunst & Florescu, 1971, as cited in Bompa, 1994)."*

There are many reasons for the critiques levelled at traditional talent identification models, and these reasons carry weight and are meritorious. Amongst these reasons are those of maturation (incorporating the relative-age-effect) and lack of a multivariate and multidisciplinary approach to talent identification that have been selected for the purposes of discussion in this section. Other aspects worthy of consideration include the problem of early specialisation in sport. These aspects will be touched upon ever so briefly before the problem formulation for this study is provided.

It has been found that those children and adolescents who mature earlier do better at sports than those who mature later (Malina *et al.,* 2004a; Philippaerts *et al.,* 2006) and this presents a challenge for talent identification (Vaeyens *et al.,* 2006). The relative-age-effect, related to maturation, is where those born early in the year have a physical advantage over those born later in the year (Musch & Grondin, 2001; Baker *et al.,* 2003c; Hyllegard, 2005; Vaeyens *et al.,* submitted) with Vaeyens *et al.* (submitted) and others saying that this can have an impact on participation at higher levels and selection.

Furthermore, the more traditional methods of using motor and physical tests to determine and select talent are questioned due to the fact that these factors do not fully account for talented performance in sport. In their study on 405 handball players ranging in age from 12 to 13 years, Lidor *et al.* (2005) made recommendations that tests for cognitive aspects need to be incorporated into test protocols. In fact, Lidor *et al*. (2005) are of the opinion that the physical and cognitive aspects of sport are of equal importance and that reliance on cognition is often situation-specific.

The focus on the evaluation of game intelligence is also proposed by Falk *et al.* (2004). These cognitive aspects, along with others such as mental toughness, goal setting, perceptual-cognitive and perceptual-motor skills and abilities in sport have received extensive attention from researchers in the past as well as in the present day and are topics further investigated at length later in this study.

Early specialisation is another potential problem with talent identification and development. Earlier, the role that significant others such as family play in sport participation and achievement was mentioned. In a study on familial influence talent development in sport, Côté (1999) identified three specific phases that are prevalent in sport participation as the child advances from childhood to adolescence. These phases are the sampling, specialising and investment phases. While this theory is further discussed in chapter four, the following must be assumed; the three phases of Côté (1999) cannot be followed to a satisfactory conclusion if early specialisation has occurred. And, while the second phase of Côté (1999) and later Côté *et al.* (2007) is called the specialising phase, it is primarily associated with a narrowing of focus on one *or* two sports, but not at the expense of all else.

In taking a step back to maintain an objective perspective, this study acknowledges the *motives* behind the search for and identifying of talented children and adolescents. More often than not, the general consensus is that if younger athletes can be identified sooner, they can be properly channelled and developed so that by the time that they compete internationally, they would hopefully be world-beaters. This seems to offer tenuous support the "Deliberate Practice Theory" of Ericsson *et al*. (1993).

To summarise this theory, the general idea is that for an individual to achieve the level of "expert" in a domain of their choice, they need to deliberately and specifically practice the parts or sections that will enable them to achieve the requisite expertise required for top performance. Ericsson *et al.* (1993) state that a period of ten years or 10 000 hours of intense preparation is required to attain international level in chess and music and proposed that this would apply to other domains. This reason is sometimes proffered as motivation for the identification of talent at a young age as well as for early specialisation. While this reason does make sense, it will also be shown in subsequent chapters of this study that there are certain disadvantages to early specialisation.

It must be said though that understanding the motives behind early specialisation is not the same as endorsing these motives and this study therefore adopts an approach of that prefers personal preference and choice to pursue a particular sport; provided that these personal preferences are informed by the progression of the individual through the three phases as listed by Côté (1999) and Côté *et al.* (2007). This study is therefore pro-development and anti-early specialisation; although it is further acknowledged that some sports, such as soccer do have earlier specialisation ages than other sports such as rowing (Vaeyens *et al.,* submitted).

While this study stands in support of Abbott and Collins (2002), and others, who delineate the need to develop talent identification processes that measure the capacity of an individual to develop in the future as opposed to performance at time of testing, it is prudent to note that this study is about the establishment of an identification and selection protocol and associated norms to be applied at an age where specialisation in the specific sport, namely rugby, has occurred, is occurring or is the desired outcome.

Thus, the research problem for this study can be summarised as the need to develop testing batteries and protocols that accurately identify and select rugby players who are at, or past the requisite age of specialisation. These test protocols need to be highly rugby specific and as far as possible, position specific. The test protocols should be valid and reliable with the overall goal of identifying those who are currently capable and able to compete at the highest levels.

In fact, as will be seen, this study has established protocols that are to be used at an age where elite performance in a chosen sport, i.e.: rugby, is a reality and where the developmental concerns as these relate to the effect of maturation on physiological variables can be considered to be negligible or less. In effect, these protocols and associated norms can be used to identify and select those age-group level players who have the ability to “take the step up” so to speak, or, they can be applied as minimum standards for access to elite level age-group or senior teams.

An in-depth study of the literature has been done during the course of this study and as a result, the work of numerous researchers has been evaluated. The preceding concepts that have been briefly highlighted in the preceding sections are discussed at length throughout this study. Other aspects such as the nature versus nurture debate have also been extensively reviewed. Furthermore, the development of talent identification and development approaches over the years has been evaluated and current day perspectives have been provided. It must be noted that the literature provided within the preceding discussion is a miniscule representation of the full scope of literature covered for this study.

With specific reference to rugby and particular reference to the SANZAR nations, the methods of selecting (identifying) and subsequently developing talent in rugby have been reviewed. This was done through questionnaires and correspondence with the relevant rugby bodies via electronic mail and telephone. Before doing this, however, the opinion of experts in the form of interviews with successful South African, and where possible, international coaches was sought with regards to modern requirements and trends in rugby union.

Existing test protocols have been reviewed and adapted and these test protocols were then executed and analysed by means of the requisite statistical interventions. The results have been tabulated and discussed with conclusions reached and recommendations made.

## 1.3 GOAL OF STUDY

The goals and aims of this study are:

### 1.3.1 Primary goals and aims

- To have a sound theoretical basis provided by in-depth and up-to-date research, debate and discussion that provides a sufficient foundation and basis for this study;

- To establish reviewed and alternative sport and position-specific testing protocols as well as comparative results consisting of norms and scores that will adequately identify and select those capable of participating in elite age-group rugby union.

### 1.3.2 Secondary goals and aims

- To subject this study to the normal rigours associated with academic research and excellence as well as practical relevance and value, and;
- To stimulate further research in the future pertaining not only to this study but also to talent identification in South Africa in general.

The overarching goal of this study is to contribute to the equitable and sustainable identification and development of talent in youth rugby in South Africa. Therefore, this study envisages achieving this through the following sub-goals: to develop, implement and evaluate a new and modified testing protocol that is as sport and position-specific as possible for the identification and selection of players with elite rugby potential. The goal is further to provide methods of comparison in the form of norms and scores for those who choose to utilise this testing protocol in the future.

## 1.4 HYPOTHESIS

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

1) The findings of this study will contribute meaningfully to elite rugby union by providing sport and position specific test protocols as well as norms and scores for comparison.

## 1.5 METHODS

### 1.5.1 Literature review

A literature review was conducted primarily to provide this study with a theoretical framework and background. Terrains that were focussed on were talent, talent identification, expertise and expert performance in sport. Some of the aspects classified under these terrains are the genetic versus environmental debate, maturation and related effects, psychological attributes of performance and others. The historical development of talent identification worldwide and within South Africa was a particular focus. Further considerations were the specific talent identification and development approaches of the SANZAR nations. This information was obtained via correspondence with the relevant organisations and through the utilisation of questionnaires.

Throughout this literature review comparisons are made, opinions are formulated and schools of thought are critically evaluated and commented upon. The domain of sport and the unique South African perspective was constantly considered. This was done so as to provide and exhaustive framework for this study.

The premise was made that as much background information as possible needs to be garnered to lay the foundation 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. The complete literature review can be found in chapter’s two to six.

### 1.5.2 Empirical investigation

#### 1.5.2.1 Design

*Phase 1:* Just after commencement of the literature review, a concurrent interview process was initiated by interviewing experts in the field of rugby. The prerequisites for these experts were a proven and consistent track record of success in coaching of a team as well as a track record of progressive thinking and of innovation in the game of rugby union.

Once this interview process was completed the sample groups of talented players were identified and compiled. There are 3 sample groups, i.e.: the Vodacom Cup squad consisting predominantly of the Blue Bulls U/21 Currie Cup squad (n=26), the South Africa U/21 squad (n=29) and the TUKS Rugby Academy squad (n=23). This phase was completed in the following way:

The sample groups were all part of already existing elite rugby squads and academies. The Blue Bulls U/21 squad supplied the team that played in the Currie Cup national U/21 championship. Most of the players in the Blue Bulls U/21 squad also represented the Blue Bulls in the Vodacom Cup competition and this was the reason for the inclusion of certain other Vodacom Cup squad members for testing.

The Blue Bulls Rugby Union aim to provide their age-group (U/21) players with the opportunity to play at Vodacom Cup level, and it is for this reason that almost the whole Vodacom Cup squad consisted of those who were part of the Blue Bulls U/21 Currie Cup squad that participated in the U/21 Currie Cup competition in 2005. It is for this reason that the Blue Bulls sample group is referred to as the Blue Bulls U/21 group throughout this study. The Blue Bulls U/21 team were the eventual national Currie Cup champions in 2005 and the Blue Bulls Vodacom Cup team were eventual semi-finalists in the 2005 competition.

The South Africa U/21 squad provided most of the team that competed at the IRB U/21 World Championships later in 2005 and who subsequently became the U/21 IRB World Champions.

The third group were those players selected to be part of the training provided by the TUKS Rugby Academy. A number of these players were part of some of the junior (U/21) squads of various rugby unions competing in the Currie Cup at the time of testing.

A number of the players in all three of the sample groups have advanced to become occasional or regular members of the senior run on teams or reserves that played at senior Currie Cup, Super 14, and Emerging Springbok level, with one player receiving a Springbok call-up. In the total sample an accumulative percentage of 94.8% of all the participants were 21 years old and younger, with the remainder ranging from 22 to 25 years of age.

*Phase 2:* This phase consists out of the evaluation of the talented players according to the batteries/protocols set up specifically for them. They were tested on the following occasions: the Blue Bulls U/21 group were tested in January 2005, the South African U/21 group were tested in April 2005 and the Tuks Rugby Academy group were tested in October 2005.

This test protocol was experimental in nature and was therefore under constant development and refinement. Henceforth, there were three versions of this test protocol as it was refined from test one to test two and test two to test three. This study has also provided a fourth and final version of the protocol with serving as the official protocol of this study. This final protocol can be found in Appendix C.

Therefore, since this study aimed to create alternative, sport and position specific tests and norms that were suited for field work with regards to ease of execution and practicality, certain tests were done by all the groups whereas other tests were done by certain groups only. This was primarily due to the developmental nature and the refining process of the protocols under discussion.

#### 1.5.2.2 Measuring instruments

As stated before, one of the primary aims of this study is to develop test protocols that are sport specific and secondly position specific for the game of rugby union. Protocols exist in the literature and in practice that test for talent in rugby. Reilly and Gilbourne (2003) and Reilly *et al.* (2000b) acknowledge the use of a multivariate approach to identifying talent in team games such as rugby done by Pienaar *et al.*

(1998). Pienaar and Spamer are regarded as groundbreaking researchers of talent identification in South Africa and are held in high regard.

In fact, this effective approach to talent identification was pioneered as far back as 1995 by Pienaar and Spamer (1995) in Pienaar and Spamer (1998). Similar test protocols/batteries were used by Pienaar and Spamer (1998), Pienaar *et al.* (1998; 2000), Hare (1999), Booysen (2002), Van Gent (2003), Van Gent and Spamer (2005), Plotz and Spamer (2006) and Spamer and De la Port (2006).

The protocol developed for this study is therefore broadly based on the preceding test protocols of Pienaar and Spamer (1995) in Pienaar and Spamer (1998) that were used by the subsequent studies mentioned prior. It was the intention of this study to develop, implement and review new, self-devised as well as existing alternative tests that lend themselves toward specific skill, physical motor, anaerobic capacity and vision measurement.

This reference test protocol consists of anthropometric measurements, rugby-specific skill tests and physical and motor ability tests. The revised test protocol for this study consists of anthropometrical measurements, physical motor ability tests, rugby-specific skills and a vision test. For the large part, however, the tests in some of the categories were alternatives to those more commonly used or were either self-devised and/or modified.

Included hereafter is the final version of the test protocol as it evolved during the course of this study. This protocol is the final version for this study. For an in-depth discussion as to how the protocol evolved to the final draft as indicated hereafter, as well as the motivation behind the choices and/or modification of existing tests, the development of new tests and reasons for discarding tests, please consult chapter seven of this study.

*1.5.2.2.1 Final test protocol*

*a) Anthropometrical measurements consisting of the following:*

- Body mass (Norton *et al.,* 1996; Van Gent, 2003).
- Height (Norton *et al.,* 1996; Van Gent, 2003).
- Skinfolds (4-site system of skinfold measurement)
  - Biceps, triceps, subscapular and suprailiac skinfolds (Durnin & Womersley, 1974; Hazeldine & McNab, 1991).

*b) Physical-motor measurements consisting of the following:*

- Vertical jump (Harman *et al.,* 2000).
- 10/40m dash (Hazeldine & McNab, 1991).
- T-Test (Harman *et al.,* 2000).
- 3x5x22m Anaerobic Capacity Test (self-devised and modified from the "Ten x 22m shuttle run" test of Krüger *et al.,* 2001).

*c) Rugby-specific self-devised skills tests consisting of the following:*

Core-skills

- S-Test (self-devised and modified from the (1) "pass for accuracy over 4m" and (2) the "catching while moving forward" tests of Pienaar & Spamer, 1995 in Pienaar & Spamer, 1998).
- Combination kick for distance and accuracy test (self-devised and modified from the "kick for distance" test of Pienaar & Spamer, 1995 in Pienaar & Spamer, 1998).

*d) Sport vision test consisting of the following:*

- The Accuvision1000 "30 accurate lights in total time" test (Venter & Maré, 2005; du Toit *et al.,* 2006b).

Note: the final test protocol can be found in Appendix C

#### 1.5.2.3 Data analysis and assimilation

The subjects participated in the protocols/batteries of tests that were developed over three testing sessions, with the protocol shown precedent serving as the final protocol for this study. The analysis of the data relied heavily on description. The information followed a systematic description of the concepts needed to understand the aims and objectives of this study, namely the development of a revised, alternative testing protocol for talent identification and selection.

This involved working with the data, organising the data, systematically ordering the information into understandable and easily read components, searching for patterns and links between the concepts, determining the relative importance of concepts and information under review, identifying key principles that are applicable to the concept, formulating and re-formulating revised protocols for testing, establishing norms and standards for the final test protocol and finally, making conclusions and formulating recommendations for this study and subsequent future research endeavours.

The information obtained from the sample was captured onto a computer and analysed by means of the Statistical Product and Service Solutions package. Since the envisaged sample is relatively small, non-parametric statistics were used to analyse the data. Non-parametric tests, also known as distribution-free tests, are a class of tests that do not rely on a parameter estimation and/or distribution assumptions (Howell, 1992).

At this juncture it is pertinent to note that this study experienced challenges relating to access to elite age-group rugby teams. Due to these challenges, the sample size of this study is relatively small and as a result of this relatively small sample size, truncated simulations were carried out to establish norms for future reference. The function of these simulations were to simulate the scores obtained on these variables as if they were obtained from a much larger sample as well as to simulate the normal distribution of these variables. For these simulations to be successful and accurate, the means and standard deviations of the simulations need to be closely comparable to the original sample.

This was in fact the case, enabling the norms to be simulated by means of 250 iterations and in so doing simulating the results as if they were completed by 250 individuals. For more information on the specific statistical methods and inferences used in this study please consult chapters seven and eight of this study. The results of this study are discussed in chapter eight with the specific conclusions of this study described and the related recommendations made in chapter nine.

# CHAPTER TWO

# TALENT IDENTIFICATION: ORIENTATION OF TERMS AND CONCEPTS

## 2.1 INTRODUCTION

In any study or discussion on talent, ability and the identification thereof, the correct use and application of terminology is critical. The difficulty with accurate terminology in sports related excellence and expert performance studies is that there are differing criteria for excellence (Wrisberg, 2001). There are also greatly divergent views regarding the origin and nature of talent, with this having a resultant impact on the definitions and terminology in use (Tranckle & Cushion, 2006).

This highlights the importance of clarifying the terms and concepts applicable to this study. During the course of this study, various terms and concepts are referred to and as a result the study-specific definitions of the most commonly used of these terms and concepts have been included in this section. This does not preclude the use of other terms however.

Furthermore, an attempt has been made at providing conceptual definitions applicable not only to this present study but to future studies as well. So, with every term or concept the literature based definitions are provided while in certain circumstances further definitions are conceptualised, often in the form of an attempt to holistically combine those definitions from literature, while in some cases providing what this study views as the “more correct” definitions of the terms.

An obvious challenge in this regard, especially within the light of the divergent definitions and terminologies encountered in literature, is that when conceptualisations pertaining to standardised terminologies for specific and applicable concepts in this field are proposed, that these proposals be acceptable to all parties engaged in the study of talent, excellence and expertise. As a result of this consideration regarding the all-round acceptability of these definitions, the conceptual definitions provided by this study aim to be as generic, as all-encompassing and as inclusive as possible.

Therefore, this chapter should be regarded as a clarification of the terms inherent to this study as well as a primer for the debate that lies ahead in the following chapters with superficial discussions of many of the main issues under review later in this study being conducted in this section.

## 2.2 TERMS AND CONCEPTS

### 2.2.1 Talent

Talent is a term that is oft used to encapsulate any manner of ability or achievement in a particular domain. It is, however, a term that has elicited and provoked great debate amongst talent and expertise researchers worldwide, as will be seen in the discussion that follows.

When reviewing the definitions of talent in literature a common theme arises time and again. This theme has to do with the origin and nature of talent, i.e.: the nature-nurture debate. Therefore, while this section is not intended to debate the nature-nurture issue in-depth, since this has been done in chapter four; it is inevitable that the definitions of this concept will entail a certain level of superficial discussion along these lines.

#### 2.2.1.1 Talent vs. giftedness

Central to the argument of the origin and nature of talent (the nature vs. nurture debate) is whether talent is an inherited ability that is genetically endowed or rather something that is developed over time as a result of an individual's exposure to proper training methods and opportunities as well as their interaction with an optimal environment. Some views of talent ascribe to the extra concept of *giftedness* as an explanation of the inherited nature of ability and then refer to talent as the developed function of giftedness or high performance. Others are found to use these concepts synonymously.

Major proponents of the separateness or distinctive nature of these two terms or concepts are Van Rossum and Gagné (2005:283), who in espousing the Differential Model of Giftedness and Talent (DMGT) credited by these authors to the original work of Gagné (1985; 2003; 2005), define giftedness as *"…the possession and use of high natural ability (called aptitudes) in at least one of four ability domains, so that the level of performance places the person among the top 10% of same-age peers."* In elaborating on this DMGT model, a distinction is made between intellectual, creative, socioaffective and sensorimotor as domains of natural abilities (Van Rossum & Gagné, 2005). They then go on to define talent as *"…the demonstration of systematically developed and trained abilities in any field of human activity at a level such that the individual belongs to the top 10% of peers having had equivalent training"* (Van Rossum & Gagné, 2005:283). Others found to be proponents of this specific model are Gagné (1993), which is to be expected. But, there are also those such as Tranckle and Cushion (2006) and Vaeyens *et al.* (submitted) who hold the DMGT model in a highly favourable light.

Others, such as Tannenbaum (1993:3) regard the concepts of talent and giftedness as being synonymous, however, and define them as *"…publicly valued abilities possessed by no more than one to two percent of people at each developmental stage."* Tannenbaum (1993), it seems, makes no judgment as to the innate nature of talent or giftedness.

Heller (1993) defines talent as a gift or ability that is domain specific (i.e.: ability that is limited to a specific domain) while giftedness is described as being the potential to achieve in one or more areas. In the discussion section of Detterman (1993), Heller in Detterman (1993) once again refers to the DMGT model of Gagné (1991) that refers to giftedness as being aptitude or potential whereas talents are seen as realised abilities that are specific to a domain, with these talents and abilities reliant on development.

#### 2.2.1.2 Centrist and interactionist views of the nature and origin of talent

The definition of talent provided by Howe *et al.* (1998) has been cited by many studies and researchers. In this definition, Howe *et al.* (1998:399-400) assigned *"…five properties to talent: (1) It originates in genetically transmitted structures and hence is at least partly innate. (2) Its full effects may not be evident at an early stage, but there will be some advance indications, allowing trained people to identify the presence of talent before exceptional levels of mature performance have been demonstrated. (3) These early indications of talent provide a basis for predicting who is likely to excel. (4) Only a minority are talented, for if all children were, there would be no way to predict or explain differential success. Finally, (5) talents are relatively domain-specific."*

In their subsequent discussion of the possible mediating factors pertaining to talent and high ability it is clear that Howe *et al.* (1998) hold the view that talent and excellence are as a result of a number of factors with innate talent playing a negligible role in the development of excellence. In the peer review responses to the definition and discussion provided by Howe *et al.* (1998) that followed, as well as subsequent discussions contained in many later studies, it is clear to see that the opinions on this topic vary greatly!

While still other examples of nature-based views of talent such as those of Eysenck and Barrett (1993) who ascribe to talent as being inborn and genetic can be found, there does seem to be consensus, at least by some researchers, that talent and excellence is as a result of the combination of genetics (giftedness), environmental influences and development.

In once again referring to the definition of Van Rossum and Gagné (2005) for further clarification, it is the concept of giftedness that is heritable and it is therefore talent that is regarded as the end product of the development of these inherited abilities. To further expand on this concept, the definition of talent provided by Myburgh (1998:5), who quotes Simpson and Weiner (1989), can be noted as being *"…mental endowment; natural ability; power or ability of mind or body viewed as something* *divinely entrusted to a person for use and improvement; a special natural ability or aptitude; and a natural capacity for success in some department of mental or physical activity."*

Simonton's (1999:436) view of talent is that it is *"…'any innate capacity that enables an individual to display exceptionally high performance in a domain that requires special skills and training'"* with Simonton (2006:2) later noting that someone can be seen as possessing talent when they have *"…inherited a set of genetic traits that (a) accelerate the acquisition of domain-specific expertise and/or (b) improve the manifestation of expertise already acquired."*

What is apparent about the definition of talent supplied by both Simonton (1999) and Simonton (2006) is that the capacity to develop high levels of performance is assumed as innate or inborn and that this capacity needs training and coaching for excellence and expert performance to be observed and developed further. Therefore, although not explicitly expressed as such, it can be deduced that the concept of innate capacity (Simonton, 1999) and the ability to acquire expertise in a domain (Simonton, 2006) can be equated to the concept of giftedness (innate ability/capacity) and talent (this innate ability developed; the ability to acquire expertise through development has to be assumed in this regard) respectively, as proposed by Van Rossum and Gagné (2005) and others.

So, while genetics and heredity are acknowledged as components of talent and ability (giftedness), the important role of developing this talent is underscored time and again. The notions of most of the previous definitions supplied frames the approach adopted by Starkes (2007:90) with this approach best described by the author as being *"…somewhat more centrist"* than others, hence the adoption of the term in this section and for this study. This perspective can also be seen as being an interactionist perspective. Morgan and Giaccobi (2006) say that an interactionist approach is one that takes genetics, practice, psychological attributes and social support into account in the development of talent and high ability.

Both the centrist and interactionist approach acknowledge the role of genetics and heredity but *also* acknowledge the critical role played by factors such as opportunity, early experiences, early maturation, motivation, training and development highlighted by other studies (Howe *et al.,* 1998; Helsen *et al.,* 2000; Starkes 2000). Where these approaches differ however is that while these cited studies assign these afore-mentioned factors as *the* primary or main reasons and causes for the development of excellence and high ability, and in turn delegate the role of genetics and heredity to that of secondary importance, or on occasion, relegate it to insignificance altogether, the centrist/interactionist approach more than readily acknowledges the role of genetics and heredity.

Baker *et al.* (2003c) is a good example of a centrist/interactionist perspective in that while they acknowledge the large role that genetics and heritability play in the variation encountered when comparing the performances of individuals, they also acknowledge the equally large and important role of training and practice in the development of expertise and talent.

A balanced, centrist/interactionist approach to talent and it's origins and structure is probably the best approach to adopt since great volumes of literature abounds from the different schools of thought that, quite understandably attempt to further justify the views held by the respective proponents. This study therefore adopts the centrist/interactionist viewpoint of talent, its origin and its development.

#### 2.2.1.3 Nurture-based views of talent

In-spite of the appeal and intuitive common-sense view of the centrist approach, strict nurture-based views are held by a number of researchers. Baker and Horton (2004:211), who themselves are centrist/interactionist regarding talent and who refer to genetics and the environment as primary influences on high performance, refer in turn to Pinker (2002) who describes the environmentalist (nurture) position as being one of adopting a "blank slate" position whereby development is seen as being the result of *"…experience and learning"* only.

Deakin *et al.* (2006:305) for their part state that the *"…predominantly genetic explanation of expert performance has given way to the pervasive belief that practice and other forms of preparation are essential prerequisites for the development of expertise."*

Ericsson and Charness (1995:803) are firmly on the side proclaiming the exclusive role nurture and environmental factors playing the overriding role in excellence and expert performance when they proclaim that *"…no firm evidence exists for the effects of domain-specific talent on the acquisition of expert levels of performance."* They go on to highlight the common feeling that performance and abilities in domains gradually emerge *"…as a function of individuals' interaction with the environment"* (Ericsson & Charness, 1995:803).

In the many studies, reviews and publications of Ericsson, done on occasion with colleagues, the strictly nurture view is upheld and forwarded as being the main determinant of excellence and expert performance. The seminal work of Ericsson *et al.* (1993) highlighting the notion of deliberate practice as the primary function in the development of expertise and high performance is one such example.

Therefore, with the general arguments briefly framed, arriving at a definition for talent can be attempted. To do this, consultation of the literature is once again paramount.

**2.2.1.4 Further definitions of talent in literature**

The definition of talent provided by the Oxford Talking Dictionary (1998:npn) is that talent is *"A special natural ability or aptitude for or for a given thing. Also (rare), a thing for which one has a natural ability. Superior mental powers, skill, or ability."* It goes on to say that often talent can be seen as being *"…skill cultivated by effort."*

Reber (1985:758) describes talent as *"A high degree of ability for a particular skill"* whereas Booysen (2002:13) refers to talent as *"…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 chose arena."* The contribution of Hunt (2006) is simply that talent is channelled by an individual's interests.

The researchers and their opinions presented in this sub-section are but a microcosm of the total corps of researchers debating the issue of expertise and talent being as a result of either nature or nurture. It is possible that this debate that might never be settled or adequately resolved.

#### 2.2.1.5 Conceptual definition of talent

Referring specifically to sport, Brown (2001:3) laments the fact that dictionaries *"…do not define talent as it relates to sport."* In agreement with these sentiments, Tranckle and Cushion (2006) opine the need for and the value of a proper definition of talent within the domain of sport that is acceptable to all.

What is clear is that any definition of talent undoubtedly has to contain elements of both the heritable (nature) as well as developmental (nurture) components pertaining to this concept.

Spamer (1999:75), however, addresses both the sport specific problem mentioned by Brown (2001) and the nature-nurture issue in general literature by providing a comprehensive description of talent that states that: *"…firstly it seems that talent in sport has its origin in genetic structures, but that practice is important to develop these structures. Secondly there are early identifiers among sportspersons which can help classify these people. It is true, in the last instance, that there is a small group of talented sportspeople and that talent is related specifically to kinds of sport."* This definition of Spamer (1999) is the perfect platform from which to conceptualise a definition of talent for this study and beyond.

Talent in sport can be defined as: *1) unambiguous potential or current expressed superior ability/levels demonstrated or possessed by an individual in a chosen sport type; 2) encompassing superior levels in all the attributes, variables or parameters necessary for success in the particular sport domain involved; 3) having genetic and inherent components and characteristics, and; 4) with these genetic and inherent components heavily reliant on specific, constant and consistent developmental interventions and interactions with the immediate as well as broader environment and influences so as to improve current or future performance.*

To conclude the discussion on this concept, it is clear that talent is multi-faceted, multi-influenced and complex. This much is acknowledged by Geladas *et al.* (2007:128) who, in endorsing the definition of talent provided by Howe *et al.* (1998), then go on to say that this definition serves to *"…highlight the complex and multidimensional nature of talent."*

### 2.2.2 Skill

Lee *et al.* (2001:115) define skill as an *"…underlying capability or potential to perform at a certain level."* Skill is further defined as the *"Ability to do something (esp. manual or physical) well; proficiency, expertness, dexterity; an ability to do something, acquired through practice or learning"* (Oxford Talking Dictionary, 1998:npn). Once again, the issue of the ability to acquire skill through practice and learning are highlighted as being essential to the concept of skill. As can also be seen from this definition as well as the definition of talent, these two concepts are closely interrelated with the concept of talent integral in defining the concept of skill and vice versa.

For example, a talented individual is often referred to as being skilled at performing a certain function and conversely, a highly skilled individual is regarded as being talented and with high ability in their domain of choice. Therefore, it stands to reason that a talented individual has the ability to learn or to acquire skills or a skill at a more efficient and effective rate than those regarded as being less talented, as has been noted earlier in this chapter.

### 2.2.3 Identification

Identification is described as *"…establishment, finding out, ascertainment, diagnosis, selection, choice"* (Oxford Talking Dictionary, 1998:npn). Reber (1985:341) refers to identification as *"An act of recognising similarity or identity between events, objects or persons."*

#### 2.2.3.1 Conceptual definition of talent identification

In considering the conceptual definition of talent identification, some of the views and findings of the related literature have been taken into consideration.

Booysen (2002:13) defines talent identification as *"…identifying those individuals who possess 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."* In a study on swimming, Myburgh (1998:4), in referring to Mouton and Marais (1993), defines talent identification as a process whereby factors that have been *"…identified as components of swimming talent are observed, measured and recorded in an objective and verifiable manner."*

In their study on kayaking, Olivier and Coetsee (2002) refer to talent identification as assessing and evaluating those capacities and attributes that are essential to success in sport and that the process of talent identification can have a positive effect on the achievement of success in international competition. Williams and Reilly (2000b:658) refer to talent identification as *"…the process of recognizing current participants with the potential to become elite players."*

Pearson *et al.* (2006:278) define talent identification as *"…the recognition of natural endowment or ability of a superior quality."* Hodges *et al.* (2007:173) in turn refer to talent identification as *"…a search for abilities and characteristics that differentiate across skill levels."*

In the talent identification (and other non talent identification) studies found in literature, the multidimensional and multi-factorial nature of sport is often emphasised. It is plain to see that numerous factors and skills contribute towards achieving success in sport. In emphasising this multidimensionality of sport, Krüger *et al.* (2001:53) note that success in sport is dependant not only on morphology, but is reliant on other factors as well, such as *"…physiological characteristics, ball coordination, hand-eye-foot co-ordination, biomechanics and the player's psychology dispositions."*

Others, such as Ericsson and Lehmann (1996) confirm that these and other factors play a role in excellence, with Duncan *et al.* (2006) in turn being of the opinion that it is the physical and anthropometrical factors of an individual that are important requirements for the attainment of success in sport. Young and Pryor (2007) seem to share the outlook of Duncan and colleagues (2006) while making specific mention of the fitness aspects associated with success in sport, while Pyne *et al.* (2006) note the importance and value of anthropometric and physical fitness aspects in the process of selection and recruitment to elite sport teams that participate at the highest levels of competition.

Janelle and Hillman (2003), with Ollis *et al.* (2006) for the most part concurring, list the domains or categories needed for success in sport as consisting of physiological aspects along with technical aspects, cognitive, mental and perceptual attributes and abilities, with these attributes and abilities incorporating that of decision making. Janelle and Hillman (2003) further name the other aspects required for success in sport as being those of the control over emotions and the associated ability to cope with these emotions.

Ericsson (2007a) summarises his view that expert athletes are superior in a wide array of aspects and skills and refers to the superiority of experts in the mental representations that they acquire over time while noting the skills that experts are found to be superior in as those of anticipation and motor control. He also emphasises the consistency in performance that characterises experts when compared to others. Physically, he points out that experts and elite athletes are stronger and have higher levels of endurance and flexibility.

Pienaar and Spamer (1996b) also affirm the physical aspects inherent to sport and the need for the testing of these aspects within talent identification protocols and on their part make specific mention of du Randt (1993) who notes the importance of testing sport-specific skills in talent identification protocols. In the numerous studies focussing on rugby union by Pienaar, Spamer and various colleagues over the years (1995-2006), protocols consisting of these afore-mentioned categories have been used with great success.

Papadopoulis *et al.* (2006) list a number of studies on talent identification that are found using test batteries and protocols aimed at evaluating individual and team sports and with these protocols consisting of some or all of the of the following testing categories: anthropometrical, physiological/physical-motor and *mental skills and abilities.*

It is true, mental skills and abilities are just as important as physical skills in attaining success in sport. While Olds (2001) stresses the significance of cognitive (and other) factors in sporting success, Andrew *et al.* (2007) make mention of the need to use psychological profiling in conjunction with the physical and skill related aspects and considerations when selecting players. Abbott and Easson (2002), however, claim that there has not been a lot of focus on psychological or mental measurements in the process of talent identification and selection.

As will be seen in chapter four and five, there are growing calls for the inclusion of psychosocial considerations and mental skills tests in talent identification and development. Abbott and Collins (2004) make the case for the role of psychological and behavioural elements when considering talent identification and development, whereas Williams and Reilly (2000b) propose that sociological measures (along with other considerations) be incorporated within multi-disciplinary talent identification protocols. And, with Coetzee *et al.* (2001) correctly acknowledging the role of psychological and sociological influences in the development of talent and excellence, Falk *et al.* (2004) further drive home the point that when accurately measured, these aspects provide information on the abilities of the test subjects. They also suggest assigning relative weightings to the tests for technical ability, motor performance and cognitive aspects of performance within talent identification protocols to in so doing further assist in future predictions of performance.

Therefore, when evaluating the numerous studies on talent identification in a variety of different sports, it is clear that in practice, talent identification most certainly acknowledges the multidimensional and multi-factorial nature of sport and adopts methods of measuring these in its research designs. As stated in chapter one, Reilly *et al.* (2000b) and Reilly and Gilbourne (2003) mention the use of a multivariate approach to identifying talent in team games such as rugby and cite the work of Pienaar *et al.* (1998) in this regard. Many studies using protocols designed to identify talent contain tests that address some or all of the dimensions and categories mentioned earlier.

Furthermore, a number of studies using a multivariate approach in talent identification have as their research design a comparison of more talented groups versus less talented groups to determine the factors that discriminate most between these groups. This research design is undoubtedly a common practice; Plotz and Spamer (2006) make mention of numerous rugby-specific studies designed to concentrate on different aspects of talent within the game and in their analysis they make note of longitudinal studies focused on those players with talent potential, the development of practical models to identify talent and a host of others. It is clear that many of the studies mentioned by Plotz and Spamer (2006) have made use of multivariate and talented vs. less talented research designs.

But, on the side of the expertise and expert performance proponents, Ericsson (2007a) expresses his own reservations regarding the traditional methods and practices that test for differences between (skilled versus less skilled) individuals in various performance characteristics; this includes the role that anatomy plays in elite performance. Ericsson (2007a:9) describes his concern as being that these approaches do not provide an *"…explicit theoretical account for how the measured characteristics could explain the observed differences in representative performance."*

In a dual defence of both Ericsson's (2007a) views as well as the research designs common to talent identification as described previously, it must be mentioned that while Ericsson's (2007a) approach (and that of the expertise and expert performance perspective) is that of explaining the nature and the acquisition of expertise, expert performance and ability, talent identification is focused solely on testing for the presence of ability (talent) or, conversely, the absence thereof. The former approach can be viewed as a qualitative and descriptive approach describing and defining ability, expertise and excellence whereas the latter can be seen as being more quantitative or confirmatory in nature. See later in this chapter (two) for an elaboration on the concepts of expert performance and expertise.

This study recognises that these reservations have certain merit, but also recognises the undeniable efficacy of current talent identification methods in use. Aitken and Jenkins (1998) make note of Bompa (1985) who said that 80% of the Bulgarian medal winners at the Olympic Games in 1976 were those who were previously identified as having talent potential. Nieuwenhuis *et al.* (2002) had a prediction accuracy of 90.5%, Pienaar *et al.* (1998) achieved a success rate of 88% in predicting talent while Spamer and Winsley (2003b) make note of a prediction accuracy also exceeding 80%. Gabbett *et al.* (in press) developed a prediction function that had a 78.6% accuracy, while Falk *et al.* (2004) found a lower yet still impressive 67% accuracy of prediction in their study. Booysen (2002), when comparing the types of prediction functions commonly used in talent identification protocols, found them to be highly accurate and effective for their intended purposes as well as comparable with one another. The efficacy and successful implementation of current talent identification approaches is further supported by Hoare (1998) and Van Rossum and Gagné (2005).

A number of studies adopting different research approaches and methods have been performed on a wide array of sports with these studies focusing on various aspects of talent and the identification thereof. Selected examples of these studies include those of Myburgh (1998) on swimming, Keogh (1999) on Aussie Rules, Hoare (2000) on basketball, Hoare and Warr (2000) on women's soccer, Reilly *et al.* (2000b) on soccer, Coetzee *et al.* (2001) on swimming, Olivier and Coetsee (2002) on kayaking, Keogh *et al.* (2003) on female field hockey, Falk *et al.* (2004) on water polo, Lidor *et al.* (2005) on team handball and Elferink-Gemser *et al.* (2007) on field hockey.

In rugby league, the studies of Gabbett (2002b; 2005; 2006) provide norms as well as performance standards for the future selection of players of varying ability. And, in rugby union the studies focussed on the identification of talent in this sport are those of Pienaar and Spamer (1996b; 1998), Pienaar *et al.* (1998; 2000), Hare (1999), Spamer and Winsley (2003a; 2003b), Van Gent (2003), Van Gent and Spamer (2005), Plotz and Spamer (2006) and Spamer and De la Port (2006).

Before the definition of talent identification is provided for this study, an important distinction needs to be made between the process of talent identification and methods utilised in talent identification. The overall approach to talent identification is included in the definition provided directly hereafter and subsequent to that, whereas specific methods and models of talent identification are provided, discussed and evaluated further in chapter six of this study.

So, by incorporating and considering the above definitions, this study will summarise the approach to talent identification by formulating a conceptual definition for future reference:

Talent identification in sport can be defined as: *1) objective, valid and reliable observation, measurement and recording of specific physiological, motor-ability, sport-specific, psycho-motor and mental skills, attributes, abilities and variables that have been identified as being required components for success in a sport; 2) with the stated goal being the identification/selection of those individuals exhibiting superior levels or skilful performance in these skills, attributes, abilities and variables; 3) occurring in either cross-sectional (selection for participation) or longitudinal time-frames; 4) with the overall purpose of this process being to responsibly and ethically differentiate those who are talented from those who are less talented in a particular sport and to either a) retain those individuals identified as suited to the sport under review or, b) channel those unsuitable individuals toward the sport they are most suited to for the purpose of further development; and 5) with this future development of these individuals being to their own benefit, to the benefit of the country and to the benefit of society at large.*

To be effective in talent identification as proposed above, a multivariate approach is admittedly needed, but, a multidisciplinary approach that incorporates psychological and other dimensions within talent identification is important. The case has been made for the inclusion of these factors in test protocols throughout this study. Furthermore, in the definition above, the concept of guiding or channelling youngsters to the sport they are most suited to is noted. This concept was originally mentioned by Régnier *et al.* (1993).

*2.2.3.1.1 Talent identification vs. talent detection, selection and development*

In reviewing the opinions within the literature as these relate to the terms under discussion, certain pertinent aspects are emphasised. These aspects relate to; 1) the target population under consideration, and; 2) the time frame within which these processes occur.

In referring to the target population of these concepts, the following is found: talent identification is commonly regarded as the process of identifying or recognising talented individuals or those possessing the potential for future success and who are *currently participating* within the specific sports type under consideration, whereas talent detection is primarily regarded as the process of finding those individuals who possess the potential to be successful but who are *not currently involved* with the sport under consideration. (Williams & Reilly, 2000a; 2000b; Olivier & Coetsee, 2002; Wolstencroft, 2002; Tranckle & Cushion, 2006; Vaeyens *et al.,* submitted).

Talent selection is the process of choosing participants for their inclusion into representative teams and squads (Régnier *et al.,* 1993; Williams & Reilly, 2000b). From a practical perspective, the selection of talent can be regarded as an ongoing process, since representative teams or individuals are constantly required for competition during the normal course or duration of a season.

Other definitions of these terms as these relate solely to the time aspect of these concepts under consideration are to be found in Spamer (1999), who, in citing Salmela and Régnier (1983) states that the issue of talent selection and talent detection revolves primarily around the time frame attached to either endeavour. Talent selection is referred to by Spamer (1999:72) as *"…the prediction of achievement over a shorter period"* whereas talent detection is referred to as *"…prediction of talent over a longer period…usually followed by a development program."* Therefore, both time frames and specific target populations are essential to the processes of talent identification, detection and selection.

Still other definitions to be found include the oft quoted and cited work of Régnier *et al.* (1993:290) who refer talent detection as the process of matching *"…performer characteristics, which may be innate or subject to the effect of learning or training, to the task demands of a given sport activity to ensure the highest probability of maximum performance outcome."* Talent selection, in turn, is referred to by Régnier *et al.* (1993:290) as *"…'very short-term talent detection'"* which addresses the question of who will perform best in the eminent (short-term) time frame following selection. Furthermore, talent detection and development can be viewed as being mutual processes.

Undoubtedly, the concepts in this section must be viewed as being interrelated, but also applicable and certainly essential to one another. It is du Randt and Headley (1992a) who highlight this interrelatedness by saying that within the concept of talent identification, the concepts of talent detection, talent search and talent selection are to be found and that these processes are found at various stages of development of the sport participant.

Therefore, in expanding on these sentiments surrounding these concepts (du Randt & Headley, 1992a) and the definitions provided for these terms (Régnier *et al.,* 1993; Spamer, 1999; Williams & Reilly, 2000a; 2000b; Olivier & Coetsee, 2002; Wolstencroft, 2002; Tranckle & Cushion, 2006; Vaeyens *et al.,* submitted) and with specific reference to this study, the following definitions will apply:

a) Talent identification-(definition of the specific approach is provided prior), but the process can be defined as *the recognition of individuals currently involved in a sport who display promise or ability for excellence in this sport with the eye on further development.*

Du Randt and Headley (1992a), in referring to Régnier *et al.* (1982) mention that talent identification entails making a prediction over the long-term as to whether an individual in a general population has the ability to become an elite participant in a target (sport-specific) population that has high levels of excellence. Enabling this process involves talent detection which entails detecting youngsters or novices who are in possession of what du Randt and Headley (1992a) refer to as "talent potential"; those with this talent potential have a better chance of future success in their sport of choice when this potential is combined with the requisite development and when the growth and maturity of these individuals is favourable.

Therefore, it is from this definition that the next definition for this study is formulated.

b) Talent detection-*the long-term, ongoing process of finding potential talent from novices and beginners and those not currently participating in a specific sport.*

c) Talent selection-*involves a process of selecting those considered to be of the required standard for competition who were identified from the process of talent identification and detection for their inclusion in a team or squad for the purposes of competition.*

d) Without any further need for elaboration, the summarised definition of talent development provided by Simpson and Weiner (1989) in Myburgh (1998) is accepted as being-*the gradual expansion and bringing to fulfilment through progressive stages the latent and potential talent previously identified.*

### 2.2.4 Expert

An expert is defined as *"A person with the status of an authority (in a subject) by reason of special skill, training, or knowledge; a specialist. A person who is expert or who has gained skill from experience"* (Oxford Talking Dictionary, 1998:npn). Ericsson (2006a:3) quotes *Webster's New World Dictionary* as describing an expert as *"…'one who is very skilful and well-informed in some special field.'"*

Singer and Janelle (1999:121) have the following to say when comparing experts in sport with novices; according to these authors, experts:

*"… (1) have more elaborate task-specific knowledge;*

*(2) make more meaning of available information;*

*(3) encode and retrieve relevant information more efficiently;*

*(4) visually detect and locate objects and patterns in the visual field faster and more accurately;*

*(5) use situational probability information better; and*

*(6) make more rapid and more appropriate decisions."*

The views held by these authors are further affirmed by Baker (2003), Baker *et al.* (2003c) and others.

In quoting Webster's New Universal Unabridged Dictionary (1996), Grigorenko (2003) describes an expert as someone who is regarded as a specialist who is in possession of special or superior knowledge, skill and ability that is essential to a particular field, with this knowledge accumulating as a result of practice. Cianciolo *et al.* (2006:614) in turn simply state that an expert is *"…someone whose level of performance exceeds that of most others."*

The implications, however, are clear from most of the definitions of this term provided; becoming an expert is something acquired through extensive practice and training and that an expert shows better ability in a task or domain in relation to others. The question that remains unanswered from these definitions, however, is that of what constitutes an expert in sport? The subsequent definitions attempt to address this question.

### 2.2.5 Performance

Performance is defined as *"The execution or accomplishment of an action, operation, or process undertaken or ordered; the doing of any action or work; the quality of this, esp. as observable under particular conditions"* (Oxford Talking Dictionary, 1998:npn). A sport-specific definition of performance is provided by Lee *et al.* (2001) as exhibited and measurable motor-behaviour on a task or action.

What differentiates the term performance in expertise from that of other endeavours is the context of application. In the case of expertise, performance is qualitatively and quantitatively judged according to outcomes, with the obvious outcome being that the performance is qualitatively and quantitatively better than that of others.

#### 2.2.5.1 Conceptual definition of expert performance in sport

Expert performance in sport is defined as the superior performance of athletic and other endeavours that is consistent and that occurs over an extended period of time (Starkes, 1993; Janelle & Hillman, 2003). When further considering this aspect, the term superior usually indicates an action in comparison to another action, i.e.: superior performance of one individual over that of another. In sport the measurable aspect is even more apparent in outcomes and results. Games are won or lost, successful times run are less than others; sport performance and outcomes are inherently measurable.

What makes this concept difficult to define, however, is the issue of team sports vs. individual sports. Teams' results are measured corporately as opposed to individual sports types where the results attained are quite obviously measured individually. It has often been said that a team's whole is made up of more than the sum of its parts, with Eccles and Tenenbaum, (2004) also acknowledging this fact; what these authors further note is the importance of considering this issue within the context of a sport setting. For a team to be successful, excellent or expert performance within most or all positions is required, *along with* further aspects such as coordination, communication, cooperation and shared common goals between team members (Eccles & Tenenbaum, 2004; Hodges *et al.,* 2006).

Therefore, to simplify matters the conceptual definition provided below focuses on the performance of the individual within a team or solo context. Other factors such as team spirit, cohesion and the aspects mentioned in the preceding paragraph are not factored into this definition but, by their nature are vital to the performance of a/the team.

Expert performance in sport can be defined as: *consistent and exceptional superior performance of an individual in their sport of choice as this pertains to measurable results achieved within an individual or team context.*

The related definition of being an expert in sport can therefore be rephrased as: *an individual exhibiting consistent and exceptional superior performance in their sport of choice as this pertains to measurable results achieved within an individual or team context.*

*2.2.5.1.1 Orientation of the terms "expert performance in sport" and "elite sport"*

This study is focussed in talent identification in elite rugby. Therefore, the concept of elite sport needs to be clarified. To all intents and purposed, those who achieve expert performance in sport are elite performers selected for elite competitions or elite sport teams. Therefore, expert performance in sport is equivalent in definition to elite performance in sport and expert sports participants can be seen as elite sport participants.

Furthermore, since a number of talent identification and expert performance studies are performed on younger individuals the issue of exceptional performance in sport as compared to peers and other participants is relevant. Elite and expert performance and achievement in sport is relative to age as well as the sport under review. Grigorenko (2003:157) says as much when stating that a limiting factor to expert performance is that the *"…individual performance in the domain of expertise"* must be compared to the *"…performance of other individuals from a comparable group in the same domain."*

### 2.2.6 Expertise

Expertise is defined as *"Expert opinion or knowledge; know-how, skill, or expertness in something"* (Oxford Talking Dictionary, 1998:npn). The term expertise *"…refers to the characteristics, skills, and knowledge that distinguish experts from novices and* *less experienced people"* (Ericsson, 2006a:3). As has been shown previously and as is once again enforced in these definitions, an expert exhibits expertise in their chosen field and conversely, expertise in a field can only be exhibited by experts in that specific field.

In the definition of expertise as expounded by Grigorenko (2003), she summarises that expert performance is constituent to the knowledge component(s) essential to the domain and further comments on the fact that there is a requirement of a large amount of training to facilitate the development of this constituent knowledge. Furthermore, expert performance is limited to a specific domain and that the performance regarded as being expert in nature must in fact be superior to the performances of other individuals within the same domain. As a result, the definition of expertise and expert performance in sport can be seen as being identical.

In summary, the terms and concepts contained in this chapter by and large reflect the concepts found in literature. Further conceptualisations have been provided where necessary to adequately reflect the views of this study. This chapter also serves as a precursor to the ensuing debates contained within the subsequent chapters of this study. The concepts of sport and rugby have been examined as separate entities within the next chapter (three) of this study.

# CHAPTER THREE

# SPORT AND RUGBY

## 3.1 INTRODUCTION

Sport, with the term derived from the word “disport/dysport” (Van Gent, 2003), can be defined as *“…institutionalized competitive activities that involve rigorous physical exertion or the use of relatively complex physical skills by participants motivated by personal enjoyment and external rewards”* (Coakley, 2001:20; Wuest & Bucher, 2006:294). In the contributions of Coakley (1998; 2003), this definition of sport is also encountered, with very little amendment.

Sport has an indelible effect on both participants and spectators alike (Williams & Reilly, 2000b; Booysen, 2002; Starkes, 2003). In the arena of sport, it is the almost “super-human” feats of its stars that elicits marvel and wonder (Starkes, 2000) and it is here where legends are born (Gould *et al.,* 2002). Sport comes a long way; in fact, the earliest cave drawings depicting spear throwing have been found in Spain and France with these drawings dating back to the Ice-Age (25 000 to 10 000BC). Historians surmise that the spear was, at least initially, used for hunting and protection and served this purpose for a half a million years throughout prehistoric period (van der Merwe, 1994).

Sport has evolved steadily since then, and is now a part of life for children worldwide (Malina *et al.,* 1982; Pienaar *et al.,* 2000), particularly in the West (Pienaar *et al.,* 1998). It could be argued that this immense popularity has contributed meaningfully to sport becoming, as Williams *et al.* (2004:328) claim, the *“…largest entertainment industry in the world.”* They go on further to claim that the final of the 2002 soccer World Cup had a worldwide viewership in excess of three billion people, an astonishing figure in anyone’s estimation.

Concomitant with this increase in the popularity of sport has been the rise of financial interests within sport, most notably that of sport sponsorship. Worldwide, the amount spent on sponsorship reached $28 billion (excluding sponsorship leverage costs) (Ali *et al.,* 2006) in 2004 and in South Africa this figure fell just short of R5 billion in 2006 (Koenderman, 2007).

It is no surprise then that within sport there is such an interest in talent identification and development and the potential role that these practices can play in directing scarce resources towards those individuals with the greatest potential to succeed (Morris, 2000; Williams, 2000; Williams & Reilly, 2000b; Abbott & Collins, 2002, 2004; Pearson *et al.,* 2006; Button & Abbott, 2007).

By now it is clear that this study is on talent identification in rugby. What this chapter serves to do is to present the concepts of sport and rugby so as to sketch a background and provide a foundation from which to progress to the next issues up for discussion in this study i.e.: the physical, genetic, environmental and psychological perspectives as these pertain both to sport in general, rugby specifically and thereafter the talent identification approaches applicable to these domains and issues.

### 3.1.1 Chapter outline

This chapter consists out of three sub-sections and progresses as follows:

*Section one: characteristics of sport*

This chapter provides a brief description of the characteristics and features of sport and how these impact on the study thereof.

*Section two: sociological and societal trends in sport*

Following this, a brief description of sport related sociological and societal trends is presented.

*Section three: historical development and current day perspectives of rugby union*
The historical development and modern day considerations of rugby worldwide and in South Africa are provided in this section.

### 3.2 CHARACTERISTICS OF SPORT

Sport can be characterised by the need to perform consistently, optimally and skilfully and to excel in an environment best described as dynamic and constantly changing. Furthermore, with the ever-increasing demands and multiple constraints on performance and ability that are inherent to sport, stress and tension can be regarded as ever-present companions (Williams & Ericsson, 2005; Hodges *et al.,* 2006; Jones *et al.,* 2007). By factoring in further considerations such as the *"…moving objects and opponents"* (Hodges *et al.,* 2006:472) encountered in various sports types, this dynamic and complicated nature of sport is further entrenched within the description of this endeavour.

Due to the nature and value attached to sport (Williams & Reilly, 2000b; Booysen, 2002; Gould *et al.,* 2002; Starkes, 2003), it is only logical that the specific issue of superior performance and excellence within this discipline would attract an increasing amount of research of late (Starkes *et al.,* 2001; Starkes & Ericsson, 2003; Williams *et al.,* 2003; Abernethy *et al.,* 2005; Williams & Ericsson, 2005; Williams & Hodges, 2005; Hodges *et al.,* 2006; McPherson & Kernodle, 2007; Vaeyens *et al.,* 2007) with some older and more recent calls for research into these aspects of expertise and excellence in sport to be more multidimensional and multidisciplinary in nature (Wrisberg, 1993, 2001; Ward & Williams, 2003).

It is obvious that the dynamic nature of sport provides some unique challenges to the study thereof, with Hodges *et al.* (2006) highlighting a number of these challenging features inherent to sport.

These are named specifically and subsequently summarised in general terms in the following section:

1) Movement (Hodges *et al.,* 2006:473)

The most inescapable feature of sport is that movement plays a vital role in the execution thereof. In addition, these movements differ in terms of relative simplicity or complexity. Other principle aspects of movement within sport to be considered are that this movement often incorporates the interactions between team-mates (Hodges *et al.,* 2006).

A further aspect only hinted at by Hodges *et al.* (2006) but that requires further elaboration is that movement needs to be considered as this relates to the interaction between opponents; while this movement is often not complementary in nature and could probably best be described as adversarial in its essence, it is movement in relation to others nonetheless.

2) Time constraints (Hodges *et al.,* 2006:473)

The authors note that the time available in sports serves to limit performance. Hodges *et al.* (2006:473) refers to *"…movement choice (response selection) and completion (response execution)"* when describing the impact of time on performance in sport.

A possibility not seemingly considered by the authors is the total length of an activity, event or match. Surely this can also serve as a limiter on performance? Decisions and courses of action are often influenced by the time available (or not available) to the competitors. An example of this in rugby could be the captain's possible decision between the options of kicking for posts as opposed to the lineout and maul when there are only five minutes left on the clock before fulltime.

3) Different abilities develop at different rates (Hodges *et al.,* 2006:473)

Perceptual-cognitive and perceptual-motor skills are needed for excellence in sport. Performance is dependant on the development of these skills but these skills are not always at the same level as this relates to their development. A typical scenario noted by the authors is one of a participant knowing what they need to do, but not yet knowing how they need to do it; this knowing how to do it is something that comes as a function of practice and increased exposure to the domain (Hodges *et al.,* 2006).

4) Differing roles (Hodges *et al.,* 2006:474)

Individuals within the same sport or even team often play totally different roles. Examples of this are the position and role requirements of a goal keeper versus a striker in soccer (Hodges *et al.,* 2006), or, of an inside centre or fullback versus a prop or hooker in rugby.

5) Teams are more than a group of individuals (Hodges *et al.,* 2006:474)

As mentioned in chapter two, a team's whole is made up of more than the sum of its parts (Eccles & Tenenbaum, 2004). The characteristics of team play and team sports are quite understandably different to those of individual sports types (Jowett & Meek, 2000b) and for a team to be successful requires excellence in the execution of both position-specific and team-orientated tasks coupled with effective communication between and the coordinated action of all team members (Hodges *et al.,* 2006).

Therefore, as illustrated above, while sport attracts an inordinate amount of research, it is a challenging and unique concept to investigate.

## 3.3 SOCIOLOGICAL AND SOCIETAL TRENDS IN SPORT

In the Old Greek educational period, contrasts were evident between the educational approaches and social structures of the two rival city states, i.e.: 1) Sparta, with their rigid educational and social system that placed the burden of education on the government, and 2) Athens, with their less rigid educational and social system that placed the responsibility of education firmly in the hands of the family (Cordasco, 1965). These contrasts could not preclude the fact that they had some things in common, such as a focus on discipline and training (Gwynne-Thomas, 1981) as well as a focus on the physical aspects of education in the form of participation in sport, most notably that of gymnastics (Cordasco, 1965). It is true that sport has played a valuable role throughout the ages in society, with Van Gent (2003:9), in quoting Frey and Massengale (1988), highlighting the traditional values inherent to sport as being those of *"Striving for excellence, achievement, humility, loyalty, self-control, respect for authority, self-discipline, hard-work and deferred gratification."*

This value of sport to society in general and South Africa specifically was emphasised by Nieuwenhuis *et al.* (2002), who in quoting the findings of the Human Sciences Research Council (HSRC) of 1982, state that sport should not be viewed as being a superfluous endeavour bereft of meaning or value, but, should be considered as being of important benefit to society and to the development of the individual. This is also the opinion of Coakley (2001:2) who refers to sport as a *"…social phenomena"* that has a deeper meaning that stretches way beyond the obvious. Subsequently, Coakley (2003:4) airs his views that sport should be regarded as being fundamental to society and that sport can be viewed as being *"…integral parts of the social and cultural contexts in which we live."*

But, as du Toit *et al.* (2006a:42) so aptly and accurately state *"Modern sport is no longer a recreational activity, but has been transformed into a profession for many top sportsmen and women."* The question can then quite rightly be asked; are the traditional values of sport still applicable to today's time and age? With the advent of professionalism and the impact of incredible financial investment in sport, can sport still be seen as the striving after deferred gratification and are the attributes of loyalty, humility and self-control still applicable.

Chapter one of this study made the case for the evolution of sport into the concept it is known and recognised by today. This sub-section of this chapter serves to briefly outline this evolution in the form of analysing the societal trends that have influenced sport.

Hollander and Burnett (2002) have described the most influential societal trends and their impact on sport. These are named specifically, followed by broader summaries and discussions of the relevant concepts. The input from other studies and publications are also considered as these relate and add value to the sentiments of the afore-mentioned authors.

Therefore, the main societal trends are those of:

1) Manipulation (Hollander & Burnett, 2002:28)

This entails the use of sport to serve the purposes and ideologies of society's leaders. These purposes and ideologies pertain to those of politics, religion and other social concerns. This is far from a recent phenomenon; sport was used as a manipulative tool as far back as Greek and Roman times (Hollander & Burnett, 2002). Coakley (2003) in particular draws attention to the increase in prominence of the role that religion plays in sport in America and Canada and also speaks of the relationship between sport and politics as well as the effect of sport on other sociological realms and domains.

Hollander and Burnett (2002) are of the opinion that the main promoters of this manipulation through sport are the military, sport and educational institutions. It can be said that the sport and physical education professions have allied themselves to governmental policies of success in sporting endeavours (Green, 1998). The other role-players mentioned by Hollander and Burnett (2002) are governmental agencies, the media and business corporations with Coakley (2003) in turn stressing the significant impact of sport on the economies of many countries.

Sport is used for the purposes of nation-building and the promotion and stimulation of national pride (Hollander & Burnett, 2002; Coakley, 1998, 2001, 2003). Hollander and Burnett (2002) even go as far as to say that sport is used as a propaganda tool. Whatever the case may be, that manipulation is found within the South African context is self evident; South Africa's victories at the IRB Rugby World Cup in 1995 and the CAF African Cup of Nations in 1996 all served as vehicles to promote unity and reconciliation (Hollander & Burnett, 2002), not to mention the recent victory at the 2007 IRB Rugby World Cup and the subsequent celebrations countrywide.

2) Institutionalisation (Hollander & Burnett, 2002:28)

According to the authors, the industrial revolution ushered in an era of production and industry on a large scale coupled with recreation that was structured and organised; sport underwent similar changes, morphing into something that could also be regarded as an institutional phenomenon (Hollander & Burnett, 2002). The industrial revolution can be defined as broad-scale technological, social and economic development and progression that stimulated the development of modern industry and the practices and processes associated therewith (Giddens, 2001; Amirault & Branson, 2006).

The founding in 1896 of the Modern Olympic Games serves as an example of the institutionalisation of sport. The sport organisations and structures that were established at national and international level to cope with the rapid spread of sport worldwide are said to have provided momentum to the ever increasing development of a societal hierarchy that was present in sport participation. Due to this hierarchical societal structure, only the more well off members of society could afford participation in free time and leisure activities, whereas those of lesser means and lower social standing often viewed competitive sport participation as an opportunity to progress up the social ladder (Hollander & Burnett, 2002).

3) Professionalisation (Hollander & Burnett, 2002:29)

Though professionalisation, sport has become a commodity of great commercial value and appeal. Granted, new and exciting opportunities for economic gain have arisen, but this is, as some would say, often at the expense of the sports participants (players) who are at the behest and service of the team owners, who are considered to be the true beneficiaries of this associated economic gain (Coakley, 1998; Hollander & Burnett, 2002). Treasure *et al.* (2000:571) put it nicely when they note the views of Ackford (1998), who in commenting on professionalism in rugby union, suggests that it is *"…the major 'players' (owners, investors, sponsors, television companies, players)"* who are all after *"…a bigger share of the profits and opportunities that professionalism has brought."*

These concepts of professionalisation, commodification and commercialisation can certainly be seen as having a direct impact on talent identification and development programmes and processes. As noted earlier, the resources assigned to the development of sport are scarce; talent identification contributes to the effective use of these resources (Morris, 2000; Williams, 2000; Williams & Reilly, 2000b; Abbott & Collins, 2002, 2004; Pearson *et al.,* 2006; Button & Abbott, 2007).

There are other noteworthy aspects surrounding the professionalisation of sport that require attention. These include the fact that athletes now have a value attached to them in monetary terms (Hollander & Burnett, 2002), much in the same way that assets have a value in general business terms. Furthermore, the ability of sport and the associated events to raise a profit is also a very real consideration (Hollander & Burnett, 2002) with the previously mentioned issue of the effect of sport on the economies of many countries (Coakley, 1998; 2001; 2003) being worthy of a mention once again. In citing Branch (1990), Hollander and Burnett (2002) note that tertiary institutions have gone on to develop curricula and study programmes aimed at capitalising on this increased significance and value in sport.

4) Segmentation (Hollander & Burnett, 2002:30)

Through segmentation the establishment of so called "niche markets" occurs, with these niche markets comprising anything from social status to aspects such as gender and age. The authors also call attention to certain niche markets that accommodate those with varying physical and mental abilities such as the Paralympics and Special Olympics. Furthermore, the adaptation of the traditional rules of sport brought about adapted versions of traditional games such as mini-golf for juniors or senior and veteran events (Hollander & Burnett, 2002).

Finally, Hollander and Burnett (2002) point to the adaptation of sports to cater for different target audiences. They include the distinction between Rugby Union, Rugby League, Australian Rules and American Football or Gridiron. Each of these forms of the game caters for a unique and specific audience.

5) Demystification (Hollander & Burnett, 2002:30)

This pertains to the expansion of personalised, sport-related knowledge. This process stimulated an ever increasing narrowing of focus in tertiary institutions from a generalist outlook to a specialist focus in the sport-related programmes on offer. This process was also facilitated by the expansion in media coverage of sport, improved technology and globalisation (all aspects discussed previously) as well as an increased ability of the world's populace to travel (Hollander & Burnett, 2002). It is a fact that over the years, travel has become cheaper and more accessible. This has allowed a larger spectrum of people to travel not only nationally but also internationally, with this serving to make the world a smaller place, so to speak, and contributing to this overall process of demystification.

Therefore, in summary, as can be seen, societal trends heavily influenced and still influence the development and progression of sport. Hollander and Burnett (2002) also argue that it is entirely possible that sport and related industries could themselves in turn have an impact on society.

There have been many occasions where sport has been used in a positive sense for social change. While the 1995 IRB Rugby World Cup and 1996 CAF Africa Cup of Nations victories have been mentioned previously (perhaps cynically) as tools in the course of societal manipulation and propaganda, their positive and constructive impact on South Africa at large cannot be underestimated. So too the gold medal of Josiah Thugwane in the Atlanta Olympic Games in 1996 (Cooper & Goodenough, 2007) and the recent crowning of South Africa as two time world champions at the IRB Rugby World Cup. These achievements and others still serve to unify and to make South Africans proud, irrespective of race, culture or creed.

## 3.4 HISTORICAL DEVELOPMENT AND CURRENT DAY PERSPECTIVES OF RUGBY UNION

### 3.4.1 The beginning

The literature on rugby and the origins thereof is unanimous in the assertion that the origin and development of rugby can be characterised by, as Smith (2006a:5) describes it, *"…mystery, conjecture and no little myth."* As far back as the Han Dynasty in China more than 2000 years ago, a football type game called "tsu-chü" was played as a military activity. In about 644 AD a Japanese game called "kemari" was popular; this game consisted of passing and kicking a leather ball between team mates without letting this ball touch the ground (van der Merwe, 1994).

Later, from ancient Greece through to Roman times the game of "Harpestum" (to snatch) was popularised. In this game, two teams wrestled for possession of a ball in a demarcated area, with the object of the game being to carry the ball over the opposition's line. The ball would be passed in the air between team mates (van der Merwe, 1994; Smith, 2006a).

While these games can be seen as antecedents to current day rugby, other games more "representative" of rugby football can be traced back to medieval (Middle Ages) times where a ball was carried, kicked or thrown by the participants and where the players could do just about anything they liked, including full contact tackling (Smith, 2006a).

The violent nature of this game is evidenced by the fact that there are documented cases of individuals who lost their lives while participating (van der Merwe, 1994; Hattingh, 2003; Evert, 2006; Smith, 2006a). This, however, did nothing to detract from the popularity of the sport that was banned between twenty and thirty times between 1314 and 1667 (van der Merwe, 1994; Evert, 2006). This game was commonly referred to as "folk-football" or the "game" and sports such as rugby, hockey and soccer can trace their origins back to this sport (van der Merwe, 1994; Hattingh, 2003; Evert, 2006).

Later, in the nineteenth century any game where a ball was kicked or thrown was referred to as football (Smith, 2006a). It was at this time, however, that rugby (rugby union) and soccer (association football) started their separate, gradual paths of evolution and development. In broad terms, these games could be classified by the different social classes and strata of players participating in these activities. Soccer, regarded as a simpler game, was traditionally preferred by the masses while rugby, considered the more complicated game, was played by the middle-class and the aristocracy (van der Merwe, 1994).

It was at Rugby School that the version of football known today as rugby union had what can be considered its genesis. While the dribbling-only soccer game was progressing in other public schools, Rugby School concerned itself with its own version of this football game. This football game was only played at Rugby School itself or by former scholars of the school, but it was as a result of the spread of the game outside of Rugby School that it further developed and ultimately flourished (Smith, 2006a).

Three catalysts have been identified by Smith (2006a) as having contributed toward the rise and spread of Rugby. In the first case, he mentions that public schools such as Cheltenham, Marlborough, Haileybury, Wellington and others were being established to educate the growing middle-classes with many of them adopting the educational model first proposed Dr. Thomas Arnold, headmaster of Rugby School in the 1830's. In this model, religion was held at centre of school life and education, with this model placing an emphasis the development of both the mind and the body (Smith, 2006a). This philosophy is sometimes referred to as "muscular Christianity" (Evert, 2006; Smith, 2006a) Furthermore, former staff and pupils of Rugby School went to different parts of the country and took with them the principles and practices of the Rugby School football game (Smith, 2006a).

A second major contributing factor of the development of this game, as proposed by Smith (2006a:9), was *"…the first ever written rules of any football code, drawn up at Rugby School in 1845"* and that ensured that the Rugby School football game spread more easily than before. These were not detailed "how to play the game" rules but referred to the most dubious or disputable areas of the game that needed clarification or revision (Smith, 2006a).

The final catalyst noted by Smith (2006a) as contributing to the spread of Rugby School football was the novel entitled "Tom Brown's School Days" published in 1857 and written by Thomas Hughes, a former scholar and football captain at Rugby School. Many well-known features of rugby were described in this book (van der Merwe, 1994; Smith, 2006a) and it went on to become very popular (Smith, 2006a).

In the newly established schools of the time there were no uniform rules and many different types of football (including rugby) were played in many forms and ways, often dictated by the facilities and the size of the playing fields that were available to the participants (van der Merwe, 1994). The game at Eton, as dictated to by the space available, was characterised by a stronger leaning toward the dribbling form of the game (Evert, 2006), whereas Rugby School had a larger area in which to play and as a consequence showed preference to a game approach in which the ball was picked up and run with (van der Merwe, 1994; Evert, 2006).

As a result of the frustrations that arose during university football games due to different interpretations of the rules and approaches by the old-boys of the respective public schools, the Cambridge Rules of 1848 were established (van der Merwe, 1994; Smith, 2006a). Since there were more representatives of Eton at the meeting to establish the Cambridge rules, the dribbling aspect of the game was favoured in these rules (Evert, 2006). Those boys who were leaving university established football clubs around the country. Some clubs experimented with both association football and Rugby football; Richmond was a prime example of an institution experimenting with both of these, as well as with another version, called Harrow football, before deciding on rugby (Smith, 2006a).

The final separation between rugby and soccer was cemented in October of 1863 when the Football Association was established (van der Merwe, 1994; Evert, 2006; Smith, 2006a), basing the laws for their game on the 1848 Cambridge Rules (Evert, 2006; Smith, 2006a). The Football Association outlawed many of the “barbaric” features inherent to the game of Rugby, further driving home the now obvious chasm between the two games. For a time still some were hopeful that the two games would come together, but it was not to be (Smith, 2006a).

In January of 1871 the Rugby Football Union (RFU) was founded (van der Merwe, 1994; Evert, 2006; Smith, 2006a). There were 21 rugby clubs present at this founding meeting that was held at the old Pall Mall restaurant in London (Evert, 2006; Smith, 2006a). The first set of laws was drafted by Leonard Maton (from the Wimbledon Hornets Rugby Club) present at the meeting, but who at the time was immobilised with a broken leg. It was not the intention of the RFU to limit membership to English clubs and schools only, hence the decision not to include the word “England” in the name (Smith, 2006a).

In 1871 the first international rugby match was played between England and Scotland (Smith, 2006a; Quarrie & Hopkins, 2007) in response to a challenge by Scottish rugby clubs (Smith, 2006a). The game was played in Edinburgh and the Scots used their home advantage to the full; four thousand home supporters, a narrow pitch that the English were unaccustomed to and a Scottish referee all served to assure the Scots a hotly disputed victory, thanks to a controversial Scottish try (Smith, 2006a).

In 1873, in spite of the fact that five clubs in Scotland and Ireland were members of the RFU, the first breakaway Union was formed in Scotland and subsequently other unions soon followed. The RFU started to evolve into the English national union, although it was still joined by member clubs from New Zealand, South Africa, Hong Kong, India, Wales, USA, Canada and Australia with the result being that four years after its inception it had over a hundred member clubs (Smith, 2006a).

But it was to be another disputed try, this time an English try against Scotland in 1884 that led to a face-off that changed the face of rugby. As a result of the RFU's refusal to compromise with Scotland over the issue, Scotland, Ireland and Wales set about establishing their own independent body called the International Rugby Football Board (IRFB) which came to life in 1886 (Smith, 2006a).

Initially the RFU refused to join or even accept this new body but later an agreement that was acceptable to all parties was reached and England took their place on this board (Evert, 2006; Smith, 2006a). The sole responsibility of the IRFB lay in the administration of the laws regarding international matches; they also introduced a standard points scoring system to remove any further irregularities in the game. In 1998 the IRFB dropped the "F" for football to become the IRB (Smith, 2006a).

### 3.4.2 Rugby in South Africa

Rugby in South Africa is an interesting affair and could be said to be a microcosm of the society, i.e.: excellent, with the potential to *consistently* be the best in the world, but not quite there yet and with many challenges still to negotiate.

Going back a bit; the first rugby match played in South Africa occurred between the army and the civil-service in Cape Town in 1862 and ended in a nil-all draw (Evert, 2006). Subsequently, the game spread throughout South Africa with the first union formed being that of Western Province in 1883, followed by others. South Africa played its first international game in 1891 against a British touring side (Evert, 2006; Smit, 2007). South Africa only became known as the Springboks on the tour of Britain in 1906 (Evert, 2006) and from then on South Africa established themselves as a major force in world rugby (Evert, 2006; Unknown Author, 2007e), with their most fiercest rival being New Zealand, whom they played against for the first time in 1921 (Evert, 2006).

The South African Rugby Football Union (SARFU) was established in 1992 (Pienaar & Spamer, 1996b; Evert, 2006). This was as a result of the merging between the then SA Rugby Board (SARB) and the SA Rugby Union (SARU). This unification opened the door to South Africa's readmission to international rugby. SARFU was established to serve as guardian of the game in South Africa and to administer the sport in this country (Evert, 2006). Subsequently, SARFU underwent another name change by dropping the "F" to become the simply the South African Rugby Union (SARU).

South African rugby has a tradition of excellence and top performance. Up and till readmission, the Springboks had a positive win record against all the rugby playing nations of the world, racking up a winning percentage of all tests played up and till that time of 72.2% (Smit, 2007). After readmission they admittedly struggled but in 1995 became world champions by winning the Rugby World Cup held in South Africa. They subsequently managed to amass a seventeen game winning streak in 1998 that also included the Tri-Nations in that same year with another title in 2004. In 2004 Jake White was named IRB World Coach of the Year with Schalk Burger named as IRB World Player of the Year and the Springboks named IRB World Team of the Year, with these results succeeding in erasing or at least softening the memories of the infamous "Kamp Staaldraad" fiasco just prior to the 2003 IRB Rugby World Cup (Unknown Author, 2007f).

In 2005 the Springboks managed to move to number two on the International Rugby Board's charts and the South African U/19 and U/21 won their respective age-group world titles (Colquhoun, 2006). Incidentally, many of the squad members of the 2005 South African U/21 team formed part of the sample group for this study.

In 2007, two South African Super 14 franchises in the Bulls and the Sharks made it to the Super 14 Final with the Bulls the eventual winners of South Africa's maiden Super 12/14 Rugby title. Later in that same year, South Africa were once again crowned World Champions at the IRB Rugby World Cup. They also achieved the accolade of being named the IRB World Team of the Year, with Bryan Habana being named the IRB World Player of the year. Jake White was also once again named the IRB World Coach of the Year. After the IRB World Cup, South Africa was also officially the number one team in the world rankings.

South African Rugby seems to constantly have issues that plague it in the boardroom (Colquhoun, 2006; 2007) with this having the potential to be translated onto the field. Hopefully the administrators are able to resolve these issues so as to put the country in the strongest position possible to successfully retain its position as the number one ranked team in the world.

### 3.4.3 Modern perspectives

It is an undisputed fact that rugby has undergone a significant evolution since the earliest changes where teams initially consisting of twenty a side were later reduced to fifteen a side in 1875 (Evert, 2006; Smith, 2006a). Further modifications to the game are described by Smith (2006a:18) as consisting of the shift from the initial team setup fielding *"…two full backs, two three quarters, two half-backs and a pack of nine forwards"* to the changes brought about in 1894 where *"…England copied the Welsh example by moving a forward backwards to play with four three-quarters."* According to the author, this setup has not been altered since this final modification was made to the game. Since then, positions have become specialised (Evert, 2006). And, in recent years, the laws of rugby have undergone regular changes to make the game more exciting to watch (Evert, 2006; Quarrie & Hopkins, 2007).

The impact of the IRB Rugby World Cup cannot be overstated. With the commencement of the first ever IRB Rugby World Cup in 1987, rugby not only had a lasting effect on the existing rugby nations of the world (Pool, 1997), but also undertook the first steps toward making the game a global sport (Millar, 2006).

Rugby can be regarded as having great prominence worldwide; in fact, it is played in over one hundred countries (Van Gent, 2003; Spamer & De la Port, 2006) and its "flagship," the IRB Rugby World Cup, now ranks as the third most watched event after the FIFA World Cup and the Olympic Games (Grant *et al.,* 2003).

Undeniably, the advent of professionalism in rugby in 1995 had a massive impact on the game (Treasure *et al.,* 2000; Garraway *et al.,* 2000; Hattingh, 2003; Van Gent, 2003; Quarrie & Hopkins, 2007). This embracing of professionalism within rugby has impacted upon many aspects of the game, including the way the game is governed, the structure of international competitions and even the value of the players (Quarrie & Hopkins, 2007). Professionalism has also resulted in an increase in pressure to perform at optimal levels with a subsequent and associated increase in injuries as a result (Garraway *et al.,* 2000; Hattingh, 2003).

The literature shows that to participate and to be successful in rugby requires mental (Hale & Collins, 2002), rugby-specific (Hale & Collins, 2002; Durandt *et al.,* 2006; Duthie, 2006), physical and tactical (Durandt *et al.,* 2006; Duthie, 2006) skills and abilities. Also, in the last century alone there have been substantial increases in the sizes of physiques in rugby players, with marked changes visible in the last twenty five to thirty five years in particular (Olds, 2001; Luger & Pook, 2004; Quarrie & Hopkins, 2007), further emphasising the constant evolutionary nature of the game.

From the preceding discussion it can be seen that sport and rugby have undergone incredible changes and evolution not only with regards to their historical and modern development but also regarding the amount of investment, personal and otherwise, that is required to achieve and attain success. Furthermore, in the study of these concepts there are obvious experimental challenges that need to be overcome.

That numerous successful studies have been completed in rugby and other diverse sporting domains is evidence that these challenges can be successfully negotiated.

In summary, this study adopts and endorses the views held by James *et al.* (2005:63), who in their opening paragraph mention that *"The continuing development of professional sport has led to an increased emphasis on the provision of technical scientific support to aid the coaching process."*

Talent identification can certainly contribute to the coaching process by facilitating the identification and selection of talented and able players for coaching, as this study endeavours to do; with this coaching occurring over the short term when coaching for competition (selection), and over the medium and long term when coaching for development (identification). Added to the afore-mentioned is that this present study has as a further aim the contribution of knowledge to the already burgeoning knowledge base underpinning rugby and in so doing hopefully helping to improve a much loved sport.

# CHAPTER FOUR

# TALENT IDENTIFICATION: PHYSICAL PERSPECTIVES, NATURE VERSUS NURTURE AND DEVELOPMENTAL CONSIDERATIONS

## 4.1 INTRODUCTION

Upon revisiting the definition of sport provided for this study, the *competitive physicality* and the associated *physical and sports skills* required for success in competitive sport (Coakley, 1998, 2001, 2003; Wuest & Bucher, 2006) are of particular interest to the discussion contained in this chapter, as well as the research community at large. Peak performance and talented, consistent displays of skill and ability require associated peak levels of abilities and the development thereof within the domain of the physical.

In all sports, the common denominator of execution and achievement is the human body, since sport is an overtly physical endeavour, albeit to varying degrees. When considering the domain of elite sport, along with the associated physical abilities and sport-specific skills required to be competitive in elite sport endeavours, there is more than enough justification for the inclusion of these physical and skill parameters in talent identification protocols as well as for their study in expert performance studies of sport in general.

What is apparent within the current process and practice of talent identification is that the protocols used to measure abilities do not seek to explain how the talent and excellence under review evolved or why it is present, but seek to merely confirm its presence (or the potential for future talented performance), or conversely its absence. As currently practiced, talent identification is an effective and successful practice, as previous examples (Aitken & Jenkins, 1998; Hoare, 1998; Pienaar *et al.,* 1998; Nieuwenhuis *et al.,* 2002; Spamer & Winsley, 2003b; Falk *et al.,* 2004; Van Rossum & Gagné, 2005; Gabbett *et al.,* in press) have shown, and can further be seen to serve as the proverbial “litmus test” for excellence and ability in sport.

Whether greater emphasis should be placed on the long-term development of talent and abilities as opposed to talent identification that predicts future talented performance from current performance measures is also a debate that persists in this field. While this specific issue probably receives less attention than the genetic versus environmental influences on performance debate presented throughout this chapter, there is certainly a groundswell of support for a greater focus on the development of talent as opposed to the perceived exclusionary practices of talent identification and selection that some feel discriminate against the free choice rights of children and participants, with this right to choice issue previously highlighted by both Régnier *et al.* (1993) and Spamer (1999). And, while certain talent development models are presented in this chapter, the specific talent identification versus development matter is presented and further discussed in chapter six of this study.

That talented performance and excellence is measurable and quantifiable is quite obvious, when judging from the amount of literature available on the topic. What is less clear, however, is the answer to the eternal question as summarised by Sellenger (2003:208) who asks: *"What makes an elite athlete? Is it talent, physiology, training, determination or a hybrid of all these factors?"* In short, this addresses the long standing issue of nature, genetics and heredity versus nurture and environmental factors that has fuelled controversy and been a topic of debate for centuries and that still rages to this day (Gabbard, 1992; Louw *et al.,* 1998; Yun Dai & Coleman, 2005; Baker & Davids, 2007a, 2007b).

And, as this chapter will show, the nature versus nurture debate is far from reaching a satisfactory, all-encompassing conclusion that satisfies everyone. But, before any evaluation of the nature/nurture issue is conducted, the related physical and developmental factors have been described.

### 4.1.1 Chapter outline

*Section one: physical parameters and factors of sport and rugby*

This sub-section presents the general physical variables such as anthropometry and physical/physiological perspectives. Other specific performance variables in sport such as strength, speed, agility and sport-specific skill are also considered.

This review also highlights the importance of the inclusion of tests for these variables in talent identification protocols. These physical parameters of sport have been traditionally tested for and examined in talent identification protocols of multiple sports, and most notably rugby.

*Section two: maturation, growth and development*

The sub-section on maturation, growth and development provides a briefly topographical review of the periods of life-span development and the phases of motor development.

This section also highlights the impact of early maturation on sport participation and selection. Furthermore, the concept of the "relative-age effect" that has been identified has having a pivotal role in sport talent development and selection is described.

*Section three: nature and genetics versus nurture and development*

In this sub-section the debate surrounding the role of genetics in elite performance in sport is reviewed and is divided into two further sub-sections.

In the first sub-section, the specific physical factors with moderate to large genetic, hereditary and heritability components commonly highlighted by research are described. This is then followed by the associated rebuttals of these genetic explanations emanating from the highly nurturist researchers in the field of sports and expert performance.

In the second sub-section the issue of nurture and development is examined further with this including a discussion of the social and environmental influences such as parental involvement and encouragement as well as the role of peers, coaches and significant others. Specific developmental models of talent and expertise in sport have also been included and discussed. This study's viewpoints regarding these models and approaches have also been provided in this section.

*Section four: summary of findings*

This section provides a summary of the findings presented in the discussion followed by the viewpoints held by this study. The summary will take the following form:

1) A review of the physical perspectives and their role within talent identification. Included in this review is an analysis of maturation and the relative-age effect.

2) An orientation of this study's perspective and stance on the nature versus nurture debate and the possible role that this plays in talent identification.

3) An orientation of this study's perspectives regarding the development of talent and the role that this plays in talent identification.

## 4.2 PHYSICAL PARAMETERS AND FACTORS IN SPORT AND RUGBY

Preceding chapters noted the multidimensionality of sport. Sport certainly is a multi-factorial and multi-dimensional activity and to attain success in sport, the possession of requisite levels of ability within these factors and dimensions is vital (Ericsson & Lehmann, 1996; Brown, 2001; Krüger *et al.,* 2001; Olds, 2001; Nieuwenhuis *et al.,* 2002; Janelle & Hillman, 2003; Elferink-Gemser *et al.,* 2004, 2007; Abbott *et al.,* 2005, 2007; Vaeyens *et al.,* 2006; Ollis *et al.,* 2006; Andrew *et al.,* 2007). Krüger *et al.* (2001), in listing the critical success factors in sport, include factors such as morphology, physiology, ball as well as hand-eye-foot co-ordination, biomechanics and psychology.

The opinion of others, such as Woodman (1985) in Nieuwenhuis *et al.* (2002), closely coincides with the views of Krüger and colleagues (2001) when they note that the factors playing a role in success include anatomy, physical determinants, motor aspects, as well as psychology. While they go on to say that these variables can be tested in talent identification protocols, they also make mention of the fact that there does not seem to be extensive agreement in the research community as to the factors that play a role in excellence in sport.

And while Janelle and Hillman (2003) and Ollis *et al.* (2006) agree that physiology plays a role in sporting success, their focus tends to be more on the technical, mental, perceptual and emotional aspects of elite performance. Vaeyens *et al.* (2006) for their part agree that the testing most of these afore-mentioned aspects is important as part of a multivariate approach, and they also note the need to consider psychosocial, neuromotor and anthropometric aspects in talent identification**.**

At this juncture, the following is of importance: cognitive (Olds, 2001) and associated mental and psychosocial factors are certainly considered to be integral variables within sporting achievement and success, and as a consequence these factors are of significant interest when considering team selection (Andrew *et al.,* 2007), and certainly when these aspects are applied to talent development, identification and subsequent selection

As chapter five shows, there is an ever increasing awareness of the importance of psychology in superior performance and it is also apparent that tests for these factors need to be and are already being incorporated into talent identification protocols, and thereby adopting a true multivariate and multidisciplinary approach to talent identification .

In this chapter however, the social variables have been isolated and reviewed separately from the psychological factors of motivation, commitment and enjoyment, since these psychological factors fall outside the scope of this chapter. The discussions and arguments surrounding these factors are reviewed at length in chapter five of this study.

In returning the focus to the physical attributes of sport; it is obvious that not all sports are the same, with this being due to the sport-specific demands and requirements of these sports that are placed on the participating (elite) athletes. The physical and physiological characteristics and profiles of the participants often differ quite notably according to the specific sport concerned (Bourgois *et al.,* 2000; Battista *et al.,* 2007), with this further emphasising the need for sport specific testing protocols and subsequent comparative profiles and norms for possible selection.

The physical variables commonly measured within talent identification protocols consist of combinations of some or an incorporation of all of the following categories: physiological/physical-motor, anthropometric and skills/technical variables (Reilly *et al.,* 2000a, 2000b; Durand-Bush & Salmela, 2001; Nieuwenhuis *et al.,* 2002; Keogh *et al.,* 2003; Falk *et al.,* 2004; Lidor *et al.,* 2005, 2007; Van Rossum & Gagné, 2005; Papadopoulis *et al.,* 2006; Vaeyens *et al.,* 2006; Elferink-Gemser *et al.,* 2007; Vaeyens *et al.,* submitted).

The measurement of these parameters for talent identification purposes in rugby is a longstanding and common practice however and is evidenced by numerous studies in this regard (Pienaar & Spamer, 1996a, 1996b, 1998; Pienaar *et al.,* 1998, 2000; Hare, 1999; Booysen, 2002; Spamer & Winsley, 2003a, 2003b; Van Gent, 2003; Van Gent & Spamer, 2005; Plotz & Spamer, 2006; Spamer & De la Port, 2006).

Therefore, the combination of physiological, anthropometrical, morphological, biomechanical and sport-specific variables and skills are all of great importance in success and achievement in (elite) sport and these need to be considered when performing talent identification (van der Walt & de Ridder, 1992). The most pertinent of these factors will be discussed in brief hereafter:

#### 4.2.1 Anthropometric and physiological variables

According to van der Walt and de Ridder (1992), the body composition and body type of an athlete contributes towards achieving success in sport and that this has been the object of study for over 2500 years. They go on to quote Maas (1974) who states that the ancient Greeks were of the opinion that the most talented individuals were the ones that had body types most suited to a specific sport type and that furthermore, if the coaches and trainers had knowledge of the morphological characteristics of the individuals under consideration, that talent could be identified, with those identified individuals standing a good chance of becoming champions.

In more recent studies, physical traits are acknowledged as having an influence on competitive success in many sports with anthropometrical (Stuelcken *et al.,* 2007; Young & Pryor, 2007) and physiological characteristics and attributes, such as strength and power (Beunen & Thomis, 2006; Duthie, 2006) being found to have a correlation with participation and success (or the potential to be successful) in sport

The study of physiological and anthropometric characteristics and attributes has been performed (in tandem or "either-or") in rugby union (Quarrie *et al.,* 1996; Quarrie & Wilson, 2000; Duthie *et al.,* 2003; 2006a), basketball (Hoare, 2000; Angyan *et al.,* 2003), rugby league (Gabbett, 2002b; 2005; 2006) and volleyball (Duncan *et al.,* 2006; Gabbett *et al.,* in press). In many of the afore-mentioned cases, the results and findings can be utilised in subsequent assessment, identification and selection procedures.

In another study on female volleyball, anthropometrical and psychophysiological variables and the effect of these factors on sport-specific skills was examined. In the findings, the psychophysiological factors accounted for 38-98% of the skilled performance, whereas the anthropometrical variables accounted for 32-83% of the skilled performance encountered (Stamm *et al.,* 2005).

Therefore, anthropometrical and physiological considerations such as aerobic and anaerobic power and capacity, muscle power and strength and the relative contributions of these to speed, agility and other physical and related aspects of skilled or superior performance in sport are major considerations in the identification of skilled or talented individuals.

Rugby union is a sport characterised by short periods of high intensity physical exertion requiring maximum strength and power, with these maximal work periods alternating with periods of low intensity aerobic activity and rest (Quarrie & Wilson, 2000; Luger & Pook, 2004; Duthie, 2006). Rugby union can be contrasted with other similar sports types such as rugby league. Rugby league, as studies have shown (Gabbett, 2002a; 2002b; 2005; 2006), has its own sport-specific requirements pertaining to aerobic and anaerobic power, muscle power, strength and intensity

Both rugby (union) and rugby league are often described as being either contact (Quarrie *et al.,* 2001; 2007) or collision (Hattingh, 2003; Gabbett, 2006; Gabbett & Domrow, in press) sports, and when compared with soccer, a sport that has its own aerobic, anaerobic, strength, speed and agility requirements, the differences between these sports is quite noteworthy. These requirements in soccer have also been the topic of discussion and study (Reilly *et al.,* 2000a; Vaeyens *et al.,* 2006), as has volleyball, a sport that in turn also has its own power, speed and agility requirements. Volleyball too can be described as a sport that consists of short periods of maximal activity at high intensity that alternate with periods of low intensity activity and rest (Gabbett & Georgieff, 2006; Gabbett *et al.,* in press). This issue of varying physical requirements in different sports merely further emphasise the need for sport-specificity in testing and analysis.

Within the specific context of rugby (union), the evolution of the game over the last three decades, and in particular since the advent of professionalism in 1995 has had a major impact on the activities pertaining to the game as well as the physical requirements for the successful participation (Quarrie & Hopkins, 2007) and the requirements for success can be assumed to have changed over this time.

Duthie (2006) provides an up-to-date analysis of the physical requirements needed for successful rugby participation and this analysis includes aspects such as work capacity, speed, strength, power and body composition in his analysis. On the basis of Duthie's (2006) analysis, these requirements are reviewed hereafter:

1) Work capacity (Duthie, 2006:3)

This refers to aerobic and anaerobic power and capacity. Maximal aerobic power is referred to as $VO_2$ max and can be defined as *"…the maximal rate at which oxygen can be consumed"* (Foss & Keteyian, 1998:40) and is measured in ml/kg. Anaerobic power is defined as *"The development of maximal or peak power during exertion; measured as work (force in kg x distance in metres) expressed per unit of time (min)"* (Foss & Keteyian, 1998:596).

Research shows that the work periods for rugby players are usually less than 4 seconds and don't often last longer than 15 seconds (Duthie *et al.,* 2005; Duthie, 2006). There are differences found between positions where forwards do more work lasting a longer duration (Deutsch *et al.,* 1998; Duthie *et al.,* 2005, Duthie, 2006) as opposed to backs, who are found to sprint more frequently than forwards (Duthie *et al.,* 2006b).

Consequently, it is found that players are heavily reliant on an effective aerobic capacity (in conjunction with a well developed anaerobic capacity) to aid in recovery between high intensity, anaerobic activities and to reduce fatigue (Turnbull *et al.,* 1995; Deutsch *et al.,* 1998; Luger & Pook, 2004; Duthie, 2006).

2) Speed (Duthie, 2006:4)

Speed is an important component and is vital to success in rugby (Duthie *et al.,* 2005; Duthie, 2006). Pearson (2001) in Van Gent (2003:50) defines speed as consisting *"…of different phases such as the start, acceleration phase, "planing out" phase and the finish. It also includes effective deceleration."* Studies show that a ten percent difference is evident between the specific positions (backs vs. forwards) with the backs being faster than the forwards (Duthie, 2006).

Within the literature the acceleration phase in sprinting has repeatedly been identified as being most significant (Luger & Pook, 2004; Duthie, 2006), due to the findings that most sprints within competition average approximately three seconds in duration (Duthie *et al.,* 2005; Duthie, 2006) with a further consideration being that most sprints during game play commence from differing starting positions and speeds as opposed to strictly stationary positions (Luger & Pook, 2004; Duthie, 2006; Duthie *et al.,* 2006b).

A final consideration with regards to speed is the combination of this aspect with sport-specific skills such as passing, catching and running with the ball, since these are intricate game skills and abilities that need to be of requisite level for success to be attained in rugby (Grant *et al.,* 2003; Duthie, 2006; Walsh *et al.,* 2007). Consequently it is suggested that some sprints are practiced with ball in hand (Duthie, 2006; Walsh *et al.,* 2007).

3) Strength and power (Duthie, 2006:4)
Strength and power are important requirements in rugby (Turnbull *et al.,* 1995) and are integral to success in elite rugby (Duthie, 2006; Duthie *et al.,* 2006a). Strength is defined as *"The maximal force or torque a muscle or muscle group can generate at a specific or determined velocity"* (Foss & Keteyian, 1998:608), whereas power is defined as *"The rate of performing work; the product of force and velocity"* (Foss & Keteyian, 1998:606). Closely related to strength and power is agility that can be defined as *"…the ability to change direction as fast as possible with the least loss of speed"* (Meir, 1993 in Van Gent, 2003:50).

Well developed strength and power qualities are needed to improve the velocity at which one runs (Young *et al.,* 1995; Duthie, 2006), the agility of the individual, with this incorporating directional changes (Young *et al.,* 2002; Luger & Pook, 2004; Duthie, 2006), the ability to produce force in the scrums (Quarrie & Wilson, 2000; Duthie, 2006) as well as the ability to effectively deal with and participate in tackles, rucks and mauls (Luger & Pook, 2004).

A certain amount of static strength and power is also required by rugby players (Duthie *et al.,* 2005; Duthie, 2006). It has been found that the forwards are most in need of this static ability (approx. 10% of total time), although backs do require a certain, albeit lower level (approx. 2% of total time) of this ability as well (Duthie, 2006).

4) Body composition (Duthie, 2006:4)

This refers to the percentage body weight that consists of fat in relation to the proportion of body weight that is made up lean tissue (Hockey, 1996). The fat free tissue component of the body, also referred to as lean body mass, is defined as *"The body weight minus the weight of the body fat"* (Foss & Keteyian, 1998:603). Body composition (including body size) and lean body mass play an important role in performance and the attainment of success in rugby. The reason for this is the role that muscle fulfils in the generation of speed, power, strength and endurance (Duthie, 2006; Duthie *et al.,* 2006a; Slater *et al.,* 2006).

If there is an increase in fat mass without a proportionate increase in muscle mass or force generation, there will be a corresponding decrease in acceleration. Furthermore, the body is required to utilise more energy in dealing with the extra loads associated with excessive adiposity, with this then having a further negative effect on performance (Duthie, 2006; Duthie *et al.,* 2006a).

Therefore, in conclusion, the importance of anthropometric, physical and physiological variables in rugby (and sport) cannot be underestimated since these factors are needed for participation in sport as well as the attainment of elite status in this sport. As a consequence, it is of great importance that these variables and parameters are tested and evaluated in talent identification protocols for rugby and serves as justification for their current, previous and continued inclusion within these protocols.

### 4.2.2 Sport-specific skill variables

The concept of testing for sport-specific skills and variables in talent identification protocols is far from a new consideration with skills tests incorporated into talent identification in rugby done as far back as 1995 by Pienaar and Spamer (1995) in Pienaar and Spamer (1998). Included in the testing protocols of most of the talent identification studies on rugby (Pienaar & Spamer, 1996a, 1996b, 1998, Pienaar *et al.,* 1998, 2000; Hare, 1999; Booysen, 2002; Van Gent, 2003; Spamer & Winsley, 2003a, 2003b; Van Gent & Spamer, 2005; Plotz & Spamer, 2006; Spamer & De la Port, 2006) are rugby specific skills evaluations.

But, it seems as if it is increasingly attracting attention in other sporting codes, if recent studies and literature (Nieuwenhuis *et al.,* 2002; Falk *et al.,* 2004; Lidor *et al.,* 2004, 2007; Gabbett & Georgieff, 2006; Vaeyens *et al.,* 2006; Elferink-Gemser *et al.,* 2007; Gabbett *et al.,* in press) are anything to go by. Furthermore, Lambert (2004) quotes Noakes who, when referring to the game of cricket, states that the skill aspects of the game require further research. This is true not only of cricket, but also of rugby and probably most other sports, as the representative sample of studies provided above shows.

In a study on water polo, ball handling ability was classified under motor-abilities along with swimming ability, indicating that Falk *et al.* (2004) regard the ability to swim "more specifically" with regards to the game requirements as being important. The study of Coetzee *et al.* (2001) highlights swim stroke characteristics as being pertinent to success and that certain kinanthropometric variables have influence on these stroke characteristics. Falk *et al.* (2004) also tested for other physical abilities in separate categories and this included a “vertical jump” while treading water, further indicating that the testing of motor (and sport-skill) abilities in conditions closely resembling the live sport environment were attempted.

In two talent identification studies on hockey, Nieuwenhuis *et al.* (2002) included nine sport-specific tests in their protocol, while Elferink-Gemser *et al.* (2007) also included sport-specific tests for technical ability. In a non-talent identification study performed on soccer to determine the effect of maturation on sport-specific abilities, Malina *et al.* (2005) make mention of various tests designed to measure ball control ability, while this current study on rugby union tried to accurately mimic the sport-specific (passing under time constraints and kicking for accuracy) skills in the development and evolution of the protocol. The rugby-specific skills tests developed for this study were based on the previous rugby-specific skills tests that were pioneered by Pienaar and Spamer (1995) in Pienaar and Spamer (1998) and it was these tests that were subsequently modified for the further purposes of this study.

Other non-talent identification based studies focussing on sport-and-game-specific variables include those of Quarrie and Wilson (2000) on force production in rugby union scrums that used highly sport specific testing apparatus as well as that of Walsh *et al.* (2007) on ball carrying factors on sprinting in rugby union. Further studies by Battista *et al.* (2007) on rowing and Bernardi *et al.* (2007) on sailing also apply sport-and-game-specific testing methods.

## 4.3 MATURATION, GROWTH AND DEVELOPMENT

In reviewing the role that physical maturation, growth and development play in the attainment and development of excellence in sport, two primary considerations are of importance in this regard. The first has to do with the life-span development periods inherent to growth, with the second being the specific phases of motor development that accompany this growth. These will be briefly touched on before proceeding to the issues that directly affect talent identification, i.e.: early maturity versus late blooming and the relative-age effect.

### 4.3.1 Periods of life-span development

The periods of life-span development are approximated, chronological, age-related behaviours and development that can be grouped into specific stages (Gabbard, 1992).

These are discussed hereafter, with input from other sources that review the same issues also included:

1) Prenatal stage (Gabbard, 1992:10)

This stage begins at conception and proceeds until birth (Gabbard, 1992; Myburgh, 1998; Sigelman & Rider, 2006).

It is in this stage that the transfer of genetic material occurs along with growth and other structural and cellular changes and modifications (Gabbard, 1992; Malina *et al.,* 2004a). This stage is further divided into two periods consisting of the embryonic period (from zero to eight weeks) and the foetal period (from eight weeks to birth) (Gabbard, 1992).

2) Infancy stage (Gabbard, 1992:10)

This stage starts at birth and proceeds until the age of two years (Gabbard, 1992; Sigelman & Rider, 2006; Whaley, 2007). Others, such as Myburgh (1998) assign to this stage the period ranging from birth to three years, and Malina *et al.* (2004a) from birth to one year. For the purposes of this study, this stage is accepted as initially indicated (birth to two years).

This is a stage of accelerated growth and development (Malina *et al.,* 2004a) and in this stage development of psychomotor attributes can be observed (Gabbard, 1992). The development of other aspects such as language, certain mental functions and ever-improving sensorimotor abilities are also observable. In this stage the infant is highly dependent on adults (Gabbard, 1992).

3) Childhood stage (Gabbard, 1992:10)

Childhood starts at two years of age and extends to twelve years of age. This stage is divided into two sections, i.e.: early childhood (two to six years) and later childhood (six to twelve years) (Gabbard, 1992; Sigelman & Rider, 2006; Whaley, 2007). Both Myburgh (1998) and Malina *et al.* (2004a) indicate that this period spans from the end of infancy to the start of adolescence.

It is in early childhood that fundamental motor-skills develop, as well as perception and the awareness of movement. This stage is also characterised by the ability of the child being able to care for him or herself. Later childhood is associated with refining and improving the motor-skills acquired in early childhood. Academic ability also improves in this stage and is characterised by tangible thought and reasoning (Gabbard, 1992).

4) Adolescence stage (Gabbard, 1992:11)

There seems to be some disagreement as to the span of this stage. At any rate, all the resources acknowledge the phase as starting anywhere between ten and twelve years of age and ranging to between eighteen and twenty two years of age (Gabbard, 1992; Myburgh. 1998; Malina *et al.,* 2004a; Sigelman & Rider, 2006; Whaley, 2007).

Adolescence is a time associated with the occurrence of major changes in the body (Pearson *et al.,* 2006). A major milestone of human development is achieved in this stage, with this being the onset of puberty. During adolescence, acceleration in the growth of height and weight is encountered and sexual maturity is reached. The indicators of sexual maturity are the development of secondary sexual characteristics in the adolescent (Gabbard, 1992; Malina *et al.,* 2004a). Gabbard (1992) goes on to emphasise that during adolescence deeper thought processes develop and improve and there is an increased personal and social awareness and concern.

5) Adulthood stage (Gabbard, 1992:11)

This stage stretches from eighteen years of age until death and can be divided into three further stages, i.e.: 1) young adulthood (from eighteen to forty years of age), 2) middle age (from forty to sixty years of age), and 3) older adulthood (from sixty years of age and older) (Gabbard, 1992). Others such as Myburgh (1998), Sigelman and Rider (2006) and Whaley (2007) provide confirmatory, yet slightly varying estimates of these stages of adulthood, with the applicable ages overlapping slightly.

### 4.3.2 Phases of motor-behaviour development

Concurrent with the progression of the individual through the stages of life-span development is the development of motor behaviour that is often specific to the age related stages presented prior. It must be strongly noted, however, that the phases of motor-development are often continual and that a certain amount of overlapping does occur. These phases are discussed hereafter:

1) Reflexive/spontaneous movement phase (Gabbard, 1992:11)

This phase starts in the uterus and continues until about the first year of life (Gabbard, 1992; Myburgh, 1998; Thomas *et al.,* 2001; Wuest & Bucher, 2006).

The nervous system is immature and the movement is therefore involuntary. As the nervous system matures, however, these involuntary reflexes and spontaneous movements are phased out as control over voluntary movement increases (Gabbard, 1992).

2) Rudimentary phase (Gabbard, 1992:12)

The rudimentary phase corresponds with the stage of infancy (birth to two years of age) (Gabbard, 1992; Myburgh, 1998; Thomas *et al.,* 2001; Wuest & Bucher, 2006).

This phase is characterised by the development of voluntary movement and behaviour in its initial form. The motor movements in this phase are primarily determined by maturation and more often than not arise in a specific order

(Gabbard, 1992). The specific movements and behaviours usually follow a sequence that includes creeping, crawling, walking and voluntary grasping (Gabbard, 1992; Myburgh, 1998; Malina *et al.,* 2004a; Wuest & Bucher, 2006).

3) Fundamental movement phase (Gabbard, 1992:12)

This phase commences and continues throughout early childhood, which starts at two years of age and lasts until approximately six or seven years of age (Gabbard, 1992; Myburgh, 1998; Thomas *et al.,* 2001; Wuest & Bucher, 2006).

In this phase, a number of fundamental movement abilities arise, such as throwing, catching and kicking a ball or other objects, running, jumping, twisting, turning, bending and others (Gabbard, 1992; Malina *et al.,* 2004a; Wuest & Bucher, 2006).

Strength is a fundamental element of motor performance and development and increases gradually and in a linear fashion during this phase. Linear, age-related improvements in tasks such as jumping, throwing, catching, running and agility can be observed. There is little gender variance encountered in this phase, although boys do tend exhibit slightly better scores than girls in some motor measures (Malina & Bouchard, 1991; Malina *et al.,* 2004a).

4) Sport skill phase (Gabbard, 1992:13)

This phase, also referred to as the specialised movement phase, corresponds roughly with the later childhood stage stretching from about six or seven years of age at onset to about twelve to fourteen years of age (Gabbard, 1992; Myburgh, 1998; Thomas *et al.,* 2001; Wuest & Bucher, 2006).

The improvement in this phase is indicated by a further development and refining of the motor skills and abilities acquired during the fundamental phase of development. Increasingly, however, these skills become more refined, combined and adapted to the sports and activities that the child currently participates in at this point (Gabbard, 1992; Myburgh, 1998; Wuest & Bucher, 2006).

5) Growth and refinement phase (Gabbard, 1992:13)

The growth and refinement phase corresponds with the onset of adolescence, ranging from twelve to fourteen years of age at commencement until about eighteen years of age (Gabbard, 1992).

In this phase, the greatest changes in motor behaviour are found. These dramatic changes are seen at the time of puberty and with the growth spurt normally associated with this milestone. The levels of hormones in the body rise and these stimulate changes in muscle and skeletal growth and this provides a platform for further motor-skill development and refinement. It is also at this stage that major gender related differences (mostly in favour of males, due to increased androgen hormone levels) become more obvious and pronounced (Gabbard, 1992).

In confirmation of the changes inherent to these phases and stages of motor and physical development, Malina and Bouchard (1991) and Malina *et al.* (2004a) note an initial and continued (mostly) linear increase in motor abilities such as throwing and jumping ability with very little gender variance encountered until adolescence. Thereafter, in most cases, a continued increase in boys is found and a levelling or even a decline in girls is encountered. As for strength; sustained or accelerated increases are observed in boys during adolescence, contrasted with a slower increase in girls in the corresponding period (Malina & Bouchard, 1991; Hansen *et al.,* 1999; Malina *et al.,* 2004a).

6) Peak performance and regression (Gabbard, 1992:13)

The pinnacle of physiological and motor function is attained in the peak performance phase that ranges from the ages of 25 to 30 years. It is regarded as a general rule that females reach maturity between the ages of 22 to 25 years of age and that males reach full maturity between the ages of 28 and 30 years (Gabbard, 1992).

Thereafter, regression of physiological and neurological functions occurs at an average rate of between 0.75% and 1% per annum. Gabbard (1992:13) refers to a phenomenon called *"…'psychomotor slowing'"* that implies a (significant) regression in performance. Specific decreases in cardiovascular capacity, muscle strength, endurance, neural function and flexibility are encountered, as is an associated increase in body fat (Gabbard, 1992).

### 4.3.3 Early maturation and sport

As is highlighted by the preceding discussion, the relative physical and motor abilities during childhood and adolescence are highly unstable and it is therefore a challenge to accurately measure and predict current and future ability and excellence in sport.

It has been shown that anthropometrical, physical and physiological characteristics of performance are at best unstable during childhood and adolescence (Ackland & Bloomfield, 1996; Williams & Reilly, 2000b; Abbott & Collins, 2002, 2004; Wolstencroft, 2002; Abbott *et al.,* 2005; Vaeyens *et al.,* submitted) and that there seems to be a decrease in the importance of kinanthropometrical influences on performance during this time (Pienaar & Spamer, 1996a; 1998; Abbott & Collins, 2002; Nieuwenhuis *et al.,* 2002; Vaeyens *et al.,* submitted).

What these arguments serve to do is to provide the impetus for psychological and mental evaluations as better predictors of success. This study acknowledges mental and psychological factors as being vital and more than more than merely incidental in importance, and therefore these factors are reviewed further in chapter five.

Further adding to the unstable character of physical determinants throughout childhood and adolescence is the issue of early maturation in sports and the challenges associated therewith. Early developers and faster maturers exhibit higher levels of physical maturity as opposed to those of average (or late) levels of maturity and are more often than not classified as gifted or talented (Williams & Reilly, 2000b; Malina *et al.,* 2004a; French *et al.,* 2007; Sherar *et al.,* 2007), since these early maturers often outperform their late maturing counterparts (Malina *et al.,* 2004a; Philippaerts *et al.,* 2006). It is quite understandable then that early maturation presents a very real challenge for successful and effective talent identification (Vaeyens *et al.,* 2006).

This challenge has been acknowledged for almost two decades already. Hahn and Gross (1990) suggest that when performing talent identification on adolescents, that the anthropometrical and physiological results be analysed according to biological age, as opposed to chronological age. Vaeyens *et al.* (submitted), in focusing on the problems with current talent identification approaches (with this issue further explored and expanded upon in chapter six), note that by comparing children to norms based on chronological age, certain youngsters may be disadvantaged by their delayed levels of maturity.

In emphasising this fact, Vaeyens *et al.* (submitted) make the point that advances in both biological and chronological age are rarely in tandem and that one aspect of maturation can lag behind the other. As a consequence of this, early maturers can have an advanced biological age and therefore experience an associated physical (and other) advantage in performance, while still falling within the same chronological age-band of their peers. Malina *et al.* (2004a) also note the advantage that early maturers enjoy over their later maturing peers in strength and motor tasks, while Malina *et al.* (1982) state that children advanced in sexual and skeletal maturity often differ with regards to their body shape, size and composition when compared to the average of their peers, and that these differences are rather significant in adolescence.

Males in late childhood to middle adolescence who display advanced maturity (i.e.: advanced biological age) in relation to their peers in the same chronological age-group, are found to possess superior speed, power and strength levels, as well as aerobic power and endurance (Malina *et al.,* 2004a, 2004b; Vaeyens *et al.,* 2005b) with this advantage being quite pronounced between the ages of thirteen and fifteen years (Malina *et al.,* 2004b; Vaeyens *et al.,* 2006).

In reaffirming this, it has been found that the differences between elite (talented) and non-elite (less talented) participants are often found to be as a result of the possession of superior levels in factors such as body size, speed, aerobic endurance, flexibility, muscular strength, sport-specific skill and other aspects (Malina *et al.,* 2007; Sherar *et al.,* 2007). These factors have now been shown to be affected by maturation. So therefore, it cannot be denied that those demonstrating early or faster rates of maturation are more often than not classified as talented (Williams & Reilly, 2000b; Sherar *et al.,* 2007).

Interesting studies have been conducted to determine the effect of maturation and related factors (these related factors include experience and body size) on functional capacity as well as sport-specific skills in soccer. The level of maturity (and related factors) in adolescent soccer players aged thirteen to fifteen years was found to have an effect on functional capacities such as power, speed and aerobic endurance (Malina *et al.,* 2004b; Vaeyens *et al.,* 2006; Vaeyens *et al.,* submitted).

What is interesting, are the findings regarding the influence of maturation (and related factors) on sport-specific skills. In the one study, these factors were not found to have a significant effect on the execution of soccer-specific skills such as overall ball control, ball shooting ability as well as ball dribbling and passing (Malina *et al.,* 2005; Vaeyens *et al.,* 2006). Malina *et al.* (2005) attribute the differences encountered between individuals in sport-specific skills to perceptual-cognitive ability or the neural control over movement. They further attribute the possible differences in sport specific skills encountered in their study to be as a result of the maturation of these two afore-mentioned factors, the responsiveness of the individual to practice and coaching or even the relationship between the athlete and the coach.

In the other study, some effect of maturation on sport-specific skills was encountered. Malina *et al.* (2007) attribute some of the variance encountered in the soccer-specific skills to the pubertal stage as well as the aerobic resistance of the individuals concerned. While these studies do present slightly opposing findings, they do further serve to highlight the possibility that maturation (and related factors) could very well have a role in the development and execution of sport-specific skills.

Maturation, as previously noted (Malina *et al.,* 2004b; Vaeyens *et al.,* 2006) along with anthropometrical characteristics such as body fat percentage, height and lean body mass have an effect on aerobic (endurance capacity) and anaerobic capacities, with these capacities improving gradually and steadily with age (Elferink-Gemser *et al.,* 2006).

What are the consequences of maturation and the issue of chronological versus biological ageing? Malina *et al.* (2004a:626) says that *"Size, physique, and performance are related in part to the timing and tempo of biological maturation, so maturity status may be a selective factor."* The authors note that it is these physical and skill aspects that are important to selection and success in specific sports. Vaeyens *et al.* (submitted) lists swimming, rowing, basketball and ice-hockey as sports in which early maturers commonly successfully participate. French *et al.* (2007) mentions soccer, whereas French and McPherson (1999) also note basketball and American football. All of these sports require well-developed physical components such as strength, speed, body size (French & McPherson, 1999; French *et al.,* 2007; Medic *et al.,* in press; Vaeyens *et al.,* submitted) and others for successful participation. Late maturers have been found to participate in sports such figure skating, dancing and gymnastics that do not have such robust or taxing physical requirements for successful participation (French & McPherson, 1999; Medic *et al.,* in press; Vaeyens *et al.,* submitted).

In summary, from the evidence presented, it certainly seems as if early maturation impacts upon success in sport participation, with this effect extending to the classifications made regarding talented performance in sport. But, while these findings generally hold true, there are exceptions that prove that all is not lost for the so-called "late bloomers."

Jones (2003) tells the story of Bob Bigelow who didn't take up basketball until the age of fourteen but still ended up being an NBA first-round draft pick. Jones (2003) says that the subject of his article, Bob Bigelow, muses as to whether the systems that run youth sport are not flawed because of the fact that they ignore the potential merits of late bloomers. It is also clear that late maturers, as evidenced by Bigelow and others, still have the ability to perform and achieve success in many of the sports traditionally associated with early maturers (Jones, 2003; Malina, 2007).

As stressed earlier, talent identification tends to find and select those individuals who exhibit early maturational characteristics. Often this is also as a result of the "relative-age effect" (to be discussed hereafter) in which players are grouped according to their year of birth, with those born early in the year consistently more represented in elite squads, subsequent development programs and the eventual attainment of success than those born in the latter part of the year (Musch & Grondin, 2001; Vaeyens *et al.,* 2005a; Vaeyens *et al.,* submitted).

Whatever the case may be, the need for longitudinal studies on talent identification such as that done by Hare (1999) or even studies that focus on age-(position)-specific attributes at different stages within adolescence such as those done by Van Gent (2003), Van Gent and Spamer (2005) and Vaeyens *et al.* (2006) is affirmed and strengthened.

The notable suggestion of Van Gent (2003) also rings true in this regard. It is important that parents, educators and coaches nurture and encourage late bloomers and maturers to persist in their participation in sport for long enough so as to benefit from the advantages that they will gain when they eventually mature and reach the same maturity status as the early maturers. But, at some point, the late maturers catch up to the early maturers, and when this happens the initial physical and maturational advantage previously held by the latter over the former is largely negated (Philippaerts *et al.,* 2006; Vaeyens *et al.,* submitted).

### 4.3.4 Relative-age effect

The "relative-age effect" or the "birth-date effect" is related to maturation and is a phenomenon that has been encountered in studies on talent identification and expert performance in sport. In this relative-age or birth-date effect it has been found that successful participants in elite sport have birth-date distributions that heavily favour the early months of the selection year (Musch & Grondin, 2001; Baker *et al.,* 2003c; Hyllegard, 2005; Vaeyens *et al.,* submitted). In fact, individuals born in the early months of the year have a distinct overall advantage of almost one year over those born at the end of the year (Musch & Grondin, 2001; Helsen *et al.,* 2005; Vaeyens *et al.,* 2005b; Sherar *et al.,* 2007) with an eye-opening example of the full-scope of this effect being provided by Vaeyens *et al.* (2005b), who illustrate the massive potential gap in ability between those born just after 1 January compared to those born just before 31 December.

The first researchers to publish their findings on this matter were Barnsley and colleagues in 1985 (Helsen *et al.,* 2000; Starkes, 2000; Medic *et al.,* in press) and since then, this phenomenon has been found time and again in a number of different studies focused on sports. What follows is a list of studies mentioning the sports in which the relative age effect has been discovered. While these studies are not the original studies performed on these sports, all of them make mention of the original studies within their texts. Others, on the other hand, are recent, specific investigations into this effect with results that confirm the presence of the relative-age effect in the sport under investigation:

The relative age effect has been found in baseball (French & McPherson, 1999; Helsen *et al.,* 2000; Starkes, 2000; Côté *et al.,* 2007; French *et al.,* 2007; Medic *et al.,* in press), hockey (French & McPherson, 1999; Hyllegard, 2005), soccer (French & McPherson, 1999; Starkes, 2000; Helsen *et al.,* 2000, 2005; Glamser & Vincent, 2004; Hyllegard, 2005; Vaeyens *et al.,* 2005a, 2005b; Côté *et al.,* 2007; Medic *et al.,* in press), tennis (French & McPherson, 1999; Côté *et al.,* 2007; Medic *et al.,* in press), American football (Helsen *et al.,* 2000; Starkes, 2000), cricket (Helsen *et al.,* 2000; Starkes, 2000; Côté *et al.,* 2007; Medic *et al.,* in press), ice hockey (Baker & Logan, 2007; Côté *et al.,* 2007; French *et al.,* 2007; Sherar *et al.,* 2007; Medic *et al.,* in press), swimming (Côté *et al.,* 2007; Medic *et al.,* in press) and volleyball (Medic *et al.,* in press).

In a study on rugby comparing the characteristics of elite 18-year old English and South African rugby players, Spamer and Winsley (2003b) encountered a significant relative-age effect whereby 64% of the English players and 71% of the South African players were born in the first half of the calendar year. These results compare favourably with those of Glamser and Vincent (2004) who, when analysing the distribution of birthdates of their sample in their study on in youth soccer in America, found that 69% of the top players were born in the first half of the year with only 12% having their birthday in the last quarter.

Worth noting once again is that as a result of this relative-age effect, individuals born within the first months of the year are consistently more represented in elite teams, subsequent development programs and the eventual attainment of success than those born in the latter months of the year (Musch & Grondin, 2001; Vaeyens *et al.,* 2005a; Côté *et al.,* 2007; Medic *et al.,* in press; Vaeyens *et al.,* submitted). These individuals are also more likely to receive the social support from significant others (Côté *et al.,* 2007) with this support inevitably contributing toward sustained participation and possible achievement of success in sport. Once again, this underlines the challenges faced by talent identification and development.

## 4.4 NATURE AND GENETICS VERSUS NURTURE AND DEVELOPMENT

It was Sir Francis Galton who, in the late 1800's first conceived the concept that he defined as "nature versus nurture" to describe talented and exceptional performance and to provide an explanation for the differences in performance and ability encountered between individuals (Klissouras, 2001; Baker *et al.,* 2003c; Yun Dai & Coleman, 2005; Baker & Davids, 2007a; Klissouras *et al.,* 2007; Starkes, 2007). And, from the literature reviewed for this section, it is quite apparent that this concept is still a topic of great debate to this very day, as Ward and Williams (2003), amongst others, confirm.

The origin of his motivation to propose this concept and oft used (and abused) phrase stems from the findings of his research that *"…eminent individuals in the British Isles were more likely to have close relatives who were also eminent-although not necessarily in the same domain-than to have distant relatives who were eminent"* (Ericsson *et al,* 1993:363), and thereby concluded that eminence was genetic and as a result of innate natural ability (Ericsson *et al.,* 1993; 2005).

Research into talent and exceptional, expert or elite performance and related issues has spanned a century or more (Ackerman & Beier, 2003; Baker & Horton, 2004). There is however *still little or no consensus* as to the origin of talent and expert/elite performance (Helsen & Starkes, 1999; Singer & Janelle, 1999; Baker & Horton, 2004; Baker & Davids, 2007a) with the two most commonly held views *still* being that talent and expert/elite performance is *either* genetic in nature (Baker & Horton, 2004; Sigelman & Rider, 2006; Geladas *et al.,* 2007; Klissouras *et al.,* 2007) *or* due to continued, specific training and practice, i.e.: nurture (Ericsson *et al.,* 1993, 2005; Ericsson, 1996b, 2007a, 2007b; Ericsson & Lehmann, 1996; Baker & Horton, 2004; Sigelman & Rider, 2006).

What is clear, however, is that while the afore-mentioned researchers, and others found within the literature, reservedly acknowledge the existence of counter-arguments against their strongly held views, they don't treat this evidence with the gravity that it deserves. In fact, it is often observable that the evidence presented regarding the influence of factors on the development of talent and elite performance as championed by these opposite schools of thought, is as Abernethy and Côté (2007) highlight, a case of this contrary evidence being treated with disdain or even being ignored.

It is a rather unfortunate fact that there are very few researchers who adopt a more centrist or interactionist approach as advocated by Morgan and Giaccobi (2006), Starkes (2007) (see chapter two) and also by Oerter (2003), Simonton (1999; 2001; 2005; 2006; 2007) and others that embraces the role of genetics as well as practice and the environment in the development of talent, ability and expertise.

But, this continued disagreement can be expected, or at least understood to an extent, because for as long as can be remembered, historically within society individuals have been exulted for their know-how and ability and have been viewed in a light of respect and admiration. In fact, records acknowledging experts and their domains of expertise date as far back as Socrates and the Greek civilisation (Ericsson, 2006a).

*"In the 16th century humanists believed that eminent artists and scientists had received divine gifts that set them apart from the rest of us in a qualitative manner (Ericsson & Charness, 1994). The humanists argued that only these individuals possessed the innate capacities required for producing outstanding achievements in the arts and sciences"* (Ericsson, 2005:234). Advances in the fields of genetics and biology during the 19th century seemed to support this viewpoint, with the afore-mentioned Sir Galton prominent in this regard. Galton's propositions included viewing exceptionality as being the result of qualitative and quantitative differences in the brain and nervous system. He also proposed that maximal (physical) capacities be considered as being genetically constrained, and consequently unable to be extensively modified by training, apart from the initial advances experienced at onset (Ericsson & Lehmann, 1996; Ericsson, 2004, 2006a; Ericsson *et al.,* 2005). Later, however, research in the 20th century showed that the advantages enjoyed by experts were limited to their specific domain of expertise, dispelling the notion that experts were superior in all areas (Ericsson, 2005; 2006a).

This debate remains healthy and vigorous, with both the main camps deeply entrenched in their views. It is the arguments of Geladas *et al.* (2007:128-brackets added) that neatly sum up the perspective of the one side when they say that *"Top performance is an epiphenomenon (by-product) of talent"* and when they furthermore voice their opinion that *"…genes are ability multipliers and precursors of high achievement."* Obviously, not all are in agreement with these sentiments of Geladas *et al.* (2007), and it is for this reason that the debate is ongoing, and, it is for this reason that this debate is included in this section.

In a recent special issue of the International Journal of Sport Psychology, the most modern perspectives on talent, expertise and its development were reviewed, with Baker and Davids (2007a; 2007b) the editors. This sub-section commences with a discussion of the specific genetic influences on physical performance with the associated rebuttals to these influences also presented. Thereafter further nurture and developmental considerations in the form of environmental and social influences as well significant others are presented. The contributions from this special issue are also incorporated within this discussion.

### 4.4.1 Specific genetic explanations for elite performance in sport and physical proficiency with associated rebuttals

#### 4.4.1.1 Genetic explanations of elite performance in sport and physical proficiency

Simonton (1999) originally presents an interesting model called an "Emergenic and Epigenetic Model" of talent and development that is endorsed by Oerter (2003) and others. In this model he proposes that inherited giftedness and talent is made up of numerous traits (as opposed to merely one single trait) that contribute towards the expression of this exceptional ability. These inherited traits consist of many components, such as personality, mental, as well as physical and physiological aspects and it is the "multiplicative" interactions between these components that promote the development exceptionality within a given domain. It is this quality of talent that is referred to as the emergenic aspect of talent (Simonton, 1999; 2001; 2005; 2006)

This inheritance of genetic attributes and traits does not cause talent to be immediately evident at birth. These attributes undergo a process of epigenesis, whereby these various traits appear as a function of time and are dependent upon what Simonton (2005:275) refers to as *"…innate epigenetic paths of development."* That is, these traits are displayed and become apparent at various times, as a result of their various interactions with the environment.

It is this genetic-environment interplay that is referred to as epigenetics and this simply means that there are inherited capacities for genes to develop over time via the interaction between the gene and the environment (Hawke, 2007). Oerter (2003) further proposes a genotype-environment interaction model of Scarr and McCartney (1983) that also promotes a gene/environment interaction that is facilitated by further input from parents and significant others, as well as life events.

Baker and Horton (2004) and Baker and Logan (2007) summarise the association between genetics and the environment very succinctly by stating that in excellence and expert performance in sport there are primary influences as well as secondary influences that contribute toward talent and ability development. Genetic, training and psychological factors and the interactions of these are classified as primary influences with the socio-cultural and other factors categorised as secondary (Baker & Horton, 2004).

But, to what extent do genetic factors and heredity (genotypes) have an effect on behaviours and performance (phenotypes) within a sporting context? Traditionally, studies aimed at investigating the genotype's influence on the phenotype and therefore the hereditary and heritability characteristics of differences between individuals are commonly in the form of twin-studies and family studies (Baker & Horton, 2004; Pearson *et al.,* 2006; Kilssouras *et al.,* 2007).

The twin model was first put into use by Merriman in 1924 (Kilssouras *et al.,* 2007) with increased and extensive study using this model occurring in the 1970's and early 1980's; the work of Venerando and Milani-Comparetti in 1970 is cited by Pérusse *et al.* (1987) as being one of the initial studies in this period. But it was Klissouras' 1971 study of the genetic influence and origin of $VO_2$ max with its findings of heritability estimates of greater than 90% for $VO_2$ max (Pérusse *et al.,* 1987; Klissouras, 2001; Hohmann & Seidel, 2003; Klissouras *et al.,* 2007) that is widely cited by many. The findings of subsequent and more recent twin studies as discussed in reviews thereof (Klissouras, 2001; Parisi *et al.,* 2001; Geladas *et al.,* 2007) have added immeasurably to the knowledge of the influence of genetics on performance.

Early family studies can be dated back to the study of Montoye *et al.* (1975) (Pérusse *et al.,* 1987) but it was the HERITAGE Family Study of Bouchard and colleagues twenty years later in 1995, as well as Bouchard *et al.* (1998; 1999; 2000) thereafter, that also focused on the genetic origin and influence on $VO_2$ max, that can be regarded as most significant with heritability estimates of between 40% and 50% (Bouchard *et al.,* 1998, 1999, 2000; Abernethy *et al.,* 2003; Ericsson, 2003b; 2007a; Malina *et al.,* 2004a; Kilssouras *et al.,* 2007). Incidentally, HERITAGE stands for *"…**HE**alth, **RI**sk factors, exercise **T**raining, **A**nd **GE**netics"* (Baker & Horton, 2004:212).

Subsequently, there have been numerous follow-up twin and family studies, as well as other research designs and reports that have either focussed on or emphasised genetic considerations such as aerobic and anaerobic power and capacity, $VO_2$ max and related issues (Fagard *et al.,* 1991; Bouchard *et al.,* 1998; 1999; Gaskill *et al.,* 2001; Klissouras, 2001; Parisi *et al.,* 2001; Pérusse *et al.,* 2001; Calvo *et al.,* 2002; Wolfarth *et al.,* 2005), Somatotype (Maridaki *et al.,* 1998 in Klissouras, 2001; Kovar, 1977 in Kilssouras *et al.,* 2007), the genetic influence on strength (Beunen *et al.,* 2003; Peeters *et al.,* 2005; Wolfarth *et al.,* 2005; Beunen & Thomis, 2006), the genetic influence on height (Harsanyi & Martin, 1986 in Hohmann & Seidel, 2003), the genetic influence on muscle fibre distribution and function (Simoneau & Bouchard, 1995 in Malina *et al.,* 2004a; MacArthur & North, 2005, 2007; Wolfarth *et* *al.,* 2005), the genetic influence on physical activity (Wolfarth *et al.,* 2005; Eriksson *et al.,* 2006; Geladas *et al.,* 2007) as well as other aspects.

To follow in this section are the findings of the contribution of heritability to superior sport performance and ability. But, before these findings can presented, it is important to note (and perhaps clarify) the specific definition of the concept of heritability as it applies in this regard.

Heritability is defined as *"…the proportion of phenotypic variance attributable to observed individual differences in actualized genetic potential and its proximity to unity signifies the relative share of the genotype"* (Klissouras *et al.,* 2007:38). In other words, heritability is an indication of the extent to which heredity (genetic makeup) as opposed to the environment affects the variation of a specific trait or ability that is often encountered between individuals (Klissouras *et al.,* 2007). Heritability estimates are often expressed as a percentage or a decimal correlation. In interpreting these indications, Klissouras (2001) and Klissouras *et al.* (2007) explain that the closer these estimates are to unity (i.e.: 100 % or a decimal correlation as close to one as possible), the greater the influence and relative contribution of genes and heredity on these differences or variations in performance.

To put it another way, heritability does not imply that high (or low) levels of physical and physiological attributes are predetermined or absolute and that the environment has no effect; it merely implies that once individuals have reached the upper limits of their performance or physical abilities with the appropriate training, that the wide interindividual differences and variances that are observed between individuals are genetic in origin. According to Geladas *et al.* (2007:128) *"Heritability describes 'what is' in a population, it does not predict 'what could be', nor does it prescribe 'what should be'. Heritability denotes probabilistic genetic influence for a population."*

In short, heritability is a percentage (or decimal) indication of the extent to which genotypes (genes) and heredity (genetic makeup) contribute towards physical attributes and factors and most certainly takes into account environmental factors such as training, exercise, familial support, coaching and the like that contribute towards the unfolding of this genetic and heredity potential.

In extending this definition, it is quite possible to have the most favourable genetic makeup to become the best participant at a specific sporting endeavour, but to never achieve this potential due to lack of training, exposure and commitment. On the contrary, however, and as Geladas *et al.* (2007) pertinently ask; does everyone have the genes to become an elite athlete with the proper training? The answer to that, according to the authors, is an emphatic no!

And it is this viewpoint that is adopted by this study. Since the literature on these genetic influences and others is voluminous in nature, a summary of the findings of the estimates and ranges of heritability and genetics and their influence on talent and excellence in sport performance is provided hereafter. Understandably, it was not possible to obtain all the original studies, so this summary consists mainly of the findings of these studies relating to the genetic and heredity impacts on the physical aspects of sport performance as provided by Hohmann and Seidel (2003), Klissouras (2001) and Klissouras *et al.* (2007).

Where applicable and possible, other confirmatory studies have been included in the summary. This summary is in the form of estimates of heritability according to a percentage scale on a number of motor, physical and physiological abilities as these relate to superior sport performance and is followed thereafter by a table that summarises these findings.

It must be stressed that the literature in this regard varies considerably with regards to some estimates of heritability and genetic contribution to excellence and performance and that there is not great consensus. The percentages indicated are global, with the specific findings (and specific percentages) from the studies concerned falling within these global ranges. Therefore, this is a presentation of the genetic school of thought with the rebuttals included later.

1) Maximal aerobic power and capacity has been found to have a heritability range of anything between 40% and 93% (Fagard *et al.,* 1991; Bouchard *et al.,* 1998, 1999, 2000; Gaskill *et al.,* 2001; Klissouras, 2001; Parisi *et al.,* 2001; Hohmann & Seidel, 2003; Pérusse *et al.,* 2001; Prior *et al.,* 2003; MacArthur & North, 2005, 2007; Klissouras *et al.,* 2007) although some, such as Foss and Keteyian (1998), Gaskill *et al.* (2001) and MacArthur and North (2005) say that the heritability estimates can start from as low as between 20% to 30%.

2) Maximal anaerobic power, capacity and endurance have a heritability range of anything between 70% and 90% (Klissouras, 2001; Calvo *et al.,* 2002; Hohmann & Seidel, 2003; Klissouras *et al.,* 2007) with the specific findings of Calvo *et al.* (2002) being that the range is between 22% and 70%.

A recent finding has shed some light on the respective endurance/aerobic capacities as opposed to anaerobic capacity of individuals and sports participants. The *ACE* I/D gene has been found to play a vital role in determining both aerobic or anaerobic capacity and performance in sports participants (Hopkins, 1998; Smith, 2003b; MacArthur & North, 2005). Those individuals who possess the *ACE* D allele (form of the gene) are more predisposed toward and successful in sprint events reliant on power (MacArthur & North, 2005) and those with the *ACE* I allele (form of the gene) are more predisposed toward and successful in endurance or long distance events (Hopkins, 1998; MacArthur & North, 2005).

3) Maximal muscle strength exhibits a heritability range of between 22% and 100% (Klissouras, 2001; Beunen *et al*., 2003; Hohmann & Seidel, 2003; Peeters *et al.,* 2005; Beunen & Thomis, 2006; Klissouras *et al.,* 2007).

4) Muscle fibre type has been found to have a heritability range of between 5% and 100% (Klissouras, 2001; MacArthur & North, 2005, 2007; Klissouras *et al.,* 2007).

There are four main muscle fibre type designations. These are **Type I SO** (slow oxidative), **Type IIA FOG** (fast oxidative glycolytic), **Type IIB FG** (fast glycolytic) and **Type IIC** (unClassified). The **Type I** fibres are traditionally known as slow twitch fibres and are associated with aerobic and endurance sports and endeavours and the **Type II** fibres are traditionally known as fast twitch fibres and are associated with sports that have major power and speed requirements (Foss & Keteyian, 1998).

In similar findings to those of *ACE* I/D, another gene with variants, i.e.: *ACTN3* R577X has been found to have an integral role to play in muscle fibre type and distribution, with this having an effect on the type of sport (power versus endurance) one could excel in (Yang *et al.,* 2003; MacArthur & North, 2005, 2007; Savulescu & Foddy, 2005). Those individuals in possession of the *ACTN3* 577R allele have been found to have higher concentration of fast, **Type II** muscle fibres which are more conducive to power and sprint events. Those individuals in possession of the *ACTN3* 577X allele have been found to be more suited to long distance, aerobic type events (Yang *et al.,* 2003; MacArthur & North, 2005, 2007).

The knowledge of the existence and respective effects of both the *ACE* I/D as well as the *ACTN3* R577X genes, along with the rapidly expanding knowledge of genetics and heredity in general has raised the question of genetic testing for talent identification and sport guidance. This, along with genetic modifications to athletes and the implications thereof has been receiving a lot of attention from researchers of late (Lavin, 2000; Montgomery, 2000; Sharp, 2000; McCrory, 2003, 2005; Reilly & Gilbourne, 2003; Sellenger, 2003; MacArthur & North, 2005; Savulescu & Foddy, 2005; Miah & Rich, 2006; Trent & Alexander, 2006; Paul *et al.,* 2006; Sheridan *et al.,* 2006; Klissouras *et al.,* 2007) and is something that will be discussed later in chapter six as a proposed alternative to traditional methods of talent identification and development.

5) Motor coordination and acquisition exhibits a heritability range of between 45% and 91% (Parisi *et al.,* 2001; Hohmann & Seidel, 2003; Klissouras *et al.,* 2007). Motor activities such as walking and running seem to be more closely related to heredity than activities such as balancing and throwing (Klissouras *et al.,* 2007). Other studies have shown that the heritability estimates for movement accuracy and for movement economy are 87% and 85% respectively (Missitzi *et al.,* 2004 in Klissouras *et al.,* 2007).

6) Maturation has been found to be influenced by heritability by as much as 80% to 95% (Klissouras, 2001; Kilssouras *et al.,* 2007). Malina (2007) points out that it is the characteristics associated with early and late maturation that have an influence on behavioural, physiological and physical characteristics as these contribute toward excellence and achievement in sport. Myburgh (1998) cites the specific studies of Haywood (1986) and Gabbard (1987) to make the case that the process of biological growth and maturation is primarily determined by genetics and is furthermore resistant to influences from the outside environment.

7) Somatotype has been found to have an heritability range of between 69% and 90% (Klissouras, 2001; Kilssouras *et al.,* 2007). Kovar (1977) in Klissouras *et al.* (2007) found the heritability of ectomorphic components to be at 87%, mesomorphy to be at 75% and endomorphy to be at 69%. These figures were largely confirmed by Klissouras (1997) in Klissouras *et al.* (2007).

8) Height has been found to be approximately 85% heritable (Hohmann & Seidel, 2003).

9) Personality traits and cognitive skills have been found to be influenced by heritability by 40% to 70% (Kilssouras *et al.,* 2007). Personality trait heritability is found to be at 40% (Bouchard, 1999 in Klissouras *et al.,* 2007), whereas in other studies involving more than ten thousand pairs of twins, the heritability of general cognitive ability is found to be 50% (Plomin *et al.,* 1997 in Klissouras *et al.,* 2007).

Still other twin studies estimated perceptual speed at between 53% to 58% and spatial visualisation at between 46% and 71% (Plomin *et al.,* 2004 in Klissouras *et al.,* 2007).

What follows is Table 4.1 that provides a summary of the findings in the preceding discussion.

**Table 4.1: Heritability and genetic estimates on selected motor, physical and physiological abilities and variables.**

| VARIABLE/ABILITY | % | REFERENCE |
|---|---|---|
| $VO_2$ max | 40-93 | HS, Kli-01, Kli-07, PR's 1-7, 18, 19 |
| | 20→ | PR 5, 8, 18 |
| Maximal Anaerobic Power | 70-90 | HS, Kli-01, Kli-07, PR 20 |
| | 22-70 | PR 20 |
| *ACE* I/D | N/A | PR's 5, 9, 15 |
| Maximal Muscle Strength | 22-100 | HS, Kli-01, Kli-07, PR's 10-12 |
| Muscle Fibre Type | 5-100 | Kli-01, Kli-07, PR's 5, 6 |
| *ACTN3* R577X | N/A | PR's 5, 6, 13, 17 |
| Motor Coordination and Acquisition | 45-91 | HS, Kli-01, Kli-07, PR 16 |
| Maturation | 80-95 | Kli-01, Kli-07, PR 14 |
| Somatotype | 69-90 | Kli-01, Kli-07 |
| Height | 85 | HS |
| Personality Traits | 40 | Kli-07 |
| General Cognitive Ability | 50 | Kli-07 |
| Perceptual Speed | 53-58 | Kli-07 |
| Spatial Visualisation | 46-71 | Kli-07 |

Main Sources: Klissouras (2001) (Kli-01), Hohmann & Seidel (2003) (HS), & Klissouras *et al.* (2007) (Kli-07)

**Additional primary references:**

| **Reference** | **Ref. No.** | **Reference** | **Ref. No.** |
|---|---|---|---|
| Bouchard *et al.* (1998) | PR 1 | Beunen *et al.* (2003) | PR 11 |
| Bouchard *et al.* (1999) | PR 2 | Peeters *et al.* (2005) | PR 12 |
| Bouchard *et al.* (2000) | PR 3 | Yang *et al.* (2003) | PR 13 |
| Fagard *et al.* (1991) | PR 4 | Myburgh (1998) | PR 14 |
| MacArthur & North (2005) | PR 5 | Hopkins (1998) | PR 15 |
| MacArthur & North (2007) | PR 6 | Parisi *et al.* (2001) | PR 16 |
| Prior *et al.* (2003) | PR 7 | Savulescu & Foddy (2005) | PR 17 |
| Foss & Keteyian (1998) | PR 8 | Gaskill *et al.* (2001) | PR 18 |
| Smith (2003b) | PR 9 | Perusse *et al.* (2001) | PR 19 |
| Beunen & Thomis (2006) | PR 10 | Calvo *et al.* (2002) | PR 20 |

#### 4.4.1.2 Rebuttals, environmental and developmental considerations of talent and ability

From the preceding discussion and presentation it can be seen that the role of genetics in physical performance and success in sport is a scientifically proven and accepted fact. But, while numerous researchers acknowledge the dual role of genetics and the interaction of genes with the environment and are less formulaic regarding the interaction (Singer & Janelle, 1999; Thomas *et al.,* 2001; Abernethy *et al.,* 2003; Janelle & Hillman, 2003; Baker *et al.,* 2003c; Baker & Horton, 2004; Baker & Davids, 2007b; Hawke, 2007; Malina, 2007; Starkes, 2007), there are others who tend to adopt a safer, more cautionary view by holding to a “middle of the road” position that sees the total genetic contribution to excellence at around fifty percent (Baker, 2001; Hopkins, 2001).

Then there are those who hold to the view that deliberate practice is the only determinant of success in all domains, including sport (Ericsson *et al.,* 1993, 2005;

Ericsson & Charness, 1995; Ericsson 1996b, 2003a, 2003b, 2004, 2006c, 2007a, 2007b; Ericsson & Lehmann, 1996) and still others who view the psychosocial factors, such as support from significant others, the interaction with the environment, the type of environment (size of city) as well as the engagement in other aspects of participation in physical activity (such as deliberate play), as being possibly more important than both genetics and deliberate practice (Côté, 1999; Soberlak & Côté, 2003; Côté *et al.,* 2003, 2006, 2007; Abernethy & Côté, 2007; Baker & Logan, 2007; MacMahon *et al.,* 2007).

Therefore, this section will first present the rebuttals regarding certain of the genotype influences on phenotypes and the heritability estimates of physical differences and the relative contributions of these to success that proposed by some studies, followed by a review of the effect that social, environmental and significant others has on sport development.

*4.4.1.2.1 Rebuttals to genetic constraints on performance*

Before reviewing the specific arguments regarding genetic constraints on excellence, the views of the main proponents of these genetic constraints need to be revisited:

1) The highly “naturist” school of thought proposes that training and the environment are beneficial to the development of talent, excellence and ability only as far as the fact that practice and training assist the athlete to unfold the genetically prescribed or predetermined potential, whereas less effective practice would bring about less of the genetic potential to being; this also incorporates the epigenetic view that the ability to adapt is inherited and that adaptation occurs through interaction with the environment (Simonton, 1999, 2001, 2005, 2006; Klissouras, 2001; Oerter, 2003; Geladas *et al.,* 2007; Hawke, 2007; Klissouras *et al.,* 2007).

2) On the other hand, the opposing “nurturist” school of thought proposes that the genetic makeup of individuals does not contribute to excellence or high levels of

ability, but that expertise and excellence is attained through engaging in deliberate, focused, constructive and meaningful practice. In essence, the view held here is that there is very little innate and inborn talent and ability and that excellence and high performance is predominantly dependent on deliberate practice (Ericsson *et al.,* 1993, 2005; 2007a, 2007b; Ericsson & Charness, 1995; Ericsson 2003a, 2003b, 2007a, 2007b).

As can be seen from the ensuing discussion, it is the arguments presented by Professor K. Anders Ericsson, first author of the landmark study of the Theory of Deliberate Practice in 1993 (to be discussed later in this section) that will form the bulk of this ensuing discussion. Professor Ericsson is one of the major nurturist proponents in research circles and has presented a number of criticisms and rebuttals (all with great merit) in his work(s) regarding the innateness and constraints of genetic considerations in training, exercise, sport and a host of other domains.

*4.4.1.2.1a Genetic constraints on $VO_2$ max*

The findings from twin and family studies receive extensive criticism with regards to the genetic influence on excellence and expertise.

With regards to twin studies, the methodology used in this type of research and the subsequent findings and assumptions of these studies has proponents (Klissouras, 2001; Geladas *et al.,* 2007; Klissouras *et al.,* 2007), opponents (Foss & Keteyian, 1998; Hohmann & Seidel, 2003; Ericsson *et al.,* 2005; Ericsson, 2007a, 2007b) and those who seem undecided or uncommitted (Baker & Davids, 2007b; Malina, 2007).

Amongst the critics of twin studies there seems to be a consensus of views. These views rest on the fact that most twin studies have been conducted on sedentary or general populations and that it is doubtful that the findings of these studies can be extrapolated to elite athletic participants (Hohmann & Seidel, 2003; Ericsson *et al.,* 2007b) who have often consistently trained for a period of a decade or longer (Baker, 2001; Ericsson, 2007b). Furthermore, within twin study methodology, assumptions are made that the twins under review have been exposed to the same environmental surroundings, with Malina (2007) also doubting whether the results of these studies can be applied to elite sport contexts.

These criticisms levelled at twin studies most certainly apply to studies researching the heritability of $VO_2$ max, with some of the findings indicating extremely high levels of heritability (greater than 90%) for this parameter (Klissouras, 1971 in Kilssouras *et al.,* 2007; Klissouras, 2001). Pertinently, it is proposed that running economy (Conley & Krahenbuhl, 1980 in Ericsson, 2003b; 2007a) and physiological adaptations (Coyle *et al.,* 1991 in Ericsson, 2003b; 2007a), rather than $VO_2$ max, are better explanations (and greater contributors) to differences in performance between highly trained endurance runners.

Ericsson (2007a) refers to the recent work of St Clair Gibson and Noakes (2004) to strengthen his position. These authors recently proposed that *"…physical exhaustion is a relative rather than an absolute event"* with the proposal being that the fatigue sensation is a *"…sensory representation of the underlying neural integrative processes"* as opposed to being a measurable reduction in skeletal muscle force (St Clair Gibson & Noakes, 2004:797). This "governor" theory postulates that prior to and throughout physically challenging tasks such as exercise or training, the brain subconsciously calculates the metabolic needs of the body required to complete this task. The brain also concurrently takes the current environmental and physical conditions into account. These subconscious calculations then control the body's energy expenditure throughout this task, with the conscious sensation of fatigue arising as a result of these calculations and the body's effort in maintaining equilibrium (St Clair Gibson & Noakes, 2004).

Whether or not these findings fully lend credence to Ericsson's (2007a; 2007b) interpretation of them being alternative explanations to the traditional argument that $VO_2$ max is the primary limiting factor in exercise performance is inconclusive; as is the perception that these findings invalidate the genetic and heritability explanations for performance in sport, since, the question as to whether this "governor" is perhaps genetic in origin is neither addressed by St Clair Gibson and Noakes (2004) nor even considered by Ericsson (2007a; 2007b). Whether this argument further supports any of Professor Ericsson's extensive preceding arguments for deliberate practice and against the innateness of performance is also unclear.

What is clear is that the criticisms aimed at traditional twin studies do have merit, especially with regards to the extrapolation of the findings from studies on general population subjects to elite athletic performance. But, these criticisms have not gone unheeded by the twin-study proponents. In fact, Geladas *et al.* (2007) and Klissouras *et al.* (2007) readily acknowledge the criticisms of twin studies. But, recent studies have some way in addressing these concerns pertaining to the applicability of their findings to elite sport.

The first study of Parisi *et al.* (2001), although focused on analysing elite sport participation and ability as opposed to $VO_2$ max as before, had some interesting findings. The findings were that; 1) twin pair participation in elite sport is low and there are few twin pairs (but not necessary twins as individuals) in elite sport; 2) amongst elite swimmers, monozygotic or identical twins have a higher representation than do dizygotic or non-identical twins (57% versus 38%), indicating a zygotic effect in participation; 3) the intrapair equivalence consisted of high but *equal* values in both monozygotic and dizygotic twins regarding training patterns, anthropometry and sport performance, with this thus indicating no difference in genetic effect between monozygotic and dizygotic twins for these aspects, but; 4) it was found family and genetic effects are in fact detected in twins when compared to unrelated individuals (Parisi *et al.,* 2001).

In a second study, Kilssouras *et al.* (2001) in Klissouras *et al.* (2007) studied two monozygotic Olympic twin athletes who were considered to be identical genetically. They were also exposed to the same environmental and training influences. But, these twin brothers had different levels of achievement in terms of medals and titles.

The more successful brother had one gold and two silver Olympic medals as well as a word championship. The less successful brother finished eleventh place in one Olympic Games and had one world championship, but only in the absence of his more successful brother who did not compete at that event. Minimal physical differences were found between the two except for a higher level of lactic acid that was found in the more successful twin. There was, however, a marked difference found in the personality traits between the two. The conclusions of this study were that while genetics and training play vital roles in achievement in sport, that personality characteristics play important roles in excellence and superior performance in sport.

And, Geladas *et al.* (2007) make mention a third study by Plomin and Thompson (1993) in which it has been shown that, when compared to what is an anticipated normal distribution of unselected twins that incorporates a small percentage of top achievers in elite sports, the actual numbers of monozygotic and dizygotic twins encountered in Olympic games far exceeds expectations with regards to this anticipated normal distribution, with higher numbers of monozygotic twins participating in the Olympic games as opposed to dizygotic twins. These findings indicate an incredibly strong correlation between genetic factors and sport performance and excellence.

Turning the attention to family studies, it is the HERITAGE Family Study that has made a major contribution to our understanding of the heritability of $VO_2$ max, but that has also been on the receiving end of criticism. According to this landmark study, originally attributed to Bouchard *et al.* (1995) and subsequently to Bouchard and colleagues in 1998, 1999 and 2000, it was found that maximal oxygen uptake ($VO_2$ max) has heritability features ranging between 40% and 50% (Bouchard *et al.,* 1998, 1999, 2000; Abernethy *et al.,* 2003; Ericsson, 2003b, 2007a; Malina *et al.,* 2004a; Klissouras *et al.,* 2007).

More recent studies, such as those of Gaskill *et al.* (2001) and Pérusse *et al.* (2001) amongst others, are noted by both Baker and Horton (2004) and MacArthur and North (2005) as having expanded on the HERITAGE Family Study.

Ericsson (2003b; 2007a) however highlights a number of findings and methodological features of this study that he believes are flawed. He states that once again this study was done on a sedentary population and that this makes it difficult to extrapolate or generalise the findings to elite sport populations. Furthermore, since the HERITAGE Family Study required the participants to observe a strict training program, Ericsson (2003b; 2007a) is (sometimes sceptically) of the opinion that some of the participants may not have adhered to this training program, and that this fact could have served to skew the findings. One last criticism was levelled at the short term training regimen at only 75% of the maximum, with this study therefore not investigating the full effects of long-term training interventions (Ericsson, 2003b; 2007a).

*4.4.1.2.1b Genetic constraints on muscle fibre types*

Ericsson (2007a) further questions the relatively high levels of heritability proposed for muscle fibre type and distribution that are found in a number of studies to be anything from 10% and 100% (Klissouras, 2001; MacArthur & North, 2005, 2007; Komi *et al.,* 1977 in Ericsson, 2007a; Klissouras *et al.,* 2007). Ericsson (2007a) refers to the work of Goldspink (2003) whose findings indicate that muscle fibres can convert from one type to another type as a result of exercise and training.

In a closer review of the literature, it is observable that opinions in this regard vary. A largely accepted (and proven) view is that that muscle fibre switches are more common between the fast twitch **Type IIA FOG** (fast oxidative glycolytic), **Type IIB FG** (fast glycolytic) and **Type IIC** (unClassified) (Foss & Keteyian, 1998; Harridge *et al.,* 2002; Goldspink, 2003) that are associated with power and speed sports, than switches between these **Type II (A/B/C)** fibres and **Type I SO** (slow oxidative) fibres (Harridge *et al.,* 2002; Goldspink, 2003) that are traditionally known as slow twitch fibres and are associated with aerobic and endurance sports and endeavours. But, Foss and Keteyian (1998) are however of the opinion that switches between **Type II (A/B/C)** fibres and **Type I SO** fibres are largely unattainable by any degree of training.

Furthermore, the switching of muscle fibre types is a concession that is also made by Klissouras *et al.* (2007) and others (Pette, 2005 in Klissouras *et al.,* 2007) who acknowledge that reversible fibre type transitions do occur, with Klissouras *et al.* (2007:52) stating that *"The proportion of muscle fibers in humans is altered in response to training, detraining, immobilization and microgravity."* They also refer to findings that show that in humans, switches between **Type IIA** and **Type IIB** muscle fibres have been encountered in response to training loads, whereas in small mammals, switches between **Type II** and **Type I** have been encountered (Klissouras *et al.,* 2007).

Therefore, the evidence is at best varied. While there is ample evidence of switches between the various **Type II(A/B/C)** fibres (Foss & Keteyian, 1998; Harridge *et al.,* 2002; Goldspink, 2003; Klissouras *et al.,* 2007) in humans, the transition from **TYPE II(A/B/C)** to **Type I SO** in humans is uncommonly rare (Harridge *et al.,* 2002; Goldspink, 2003). Klissouras *et al.* (2007) say that these muscle fibre switches have been proven in small animals, while Foss and Keteyian (1998) are of the opinion that this conversion in humans is non-existent.

*4.4.1.2.1c ACE I/D gene findings*

The last so-called genetic rebuttal to be presented by this study is that of the *ACE* gene and the associated I/D alleles. To recap the significance of this gene; the D allele has been associated with speed and power attributes in individuals, while the I allele has been associated with endurance attributes. There have been a fair number of confirmatory studies that have found significances between this gene, its associated I and D alleles and the impact of this gene and its various forms on high levels of performances (Hopkins, 1998; Smith, 2003b; MacArthur & North, 2005).

On the other hand, some of these self-same studies have mentioned conflicting findings regarding the *ACE* I/D gene and the influence of this gene on performance, bringing the association of the various forms of this gene with endurance and power performance into question (Smith, 2003b; MacArthur & North, 2005; Ericsson, 2007a; Klissouras *et al.,* 2007). The best position to adopt in this regard is that of MacArthur and North (2005), who underscore the fact that most of the findings for both the presence or absence of this gene fall into two categories.

The positive findings are characterised by studies that focus on small, well defined samples, whereas the studies with negative findings are associated with studies characterised by large, contrasted and divergent samples. They further make a valid point that while the majority of the findings support that of an association between this gene and performance, the differences in the methodological approaches adopted by these afore-mentioned studies make it a challenging task to arrive at a resolution based on the disparate evidence presented (MacArthur & North, 2005).

In conclusion of this subsection; from the large amount of literature presented in this section, it is quite evident that the nature versus nurture debate and the associate views of the relative impact of genetics and the environment on performance is far from concluded and that it may in fact never reach such a status.

### 4.4.2 Role of significant others in the development of talent and excellence in sport

The role of significant others and social support in the lives of sport participants and the impact that these significant others and this support have on sport socialisation, participation, motivation and the attainment of high levels of achievement are very important and cannot be underestimated, with a number of studies highlighting this (Bloom, 1985; Van Rossum, 1995; Côté, 1999; Escarti *et al.,* 1999; Jodl *et al.,* 2001; Gould *et al.,* 2002, 2006; Lau *et al.,* 2005; Tranckle & Cushion, 2006; Williams & Richardson, 2006; Papaioannou *et al.,* in press). And, the role and impact of significant others such as parents (Gould *et al.,* 2006), coaches (Poczwardowski *et al.,* 2006) and the effect of significant others on motivation in sport (Bengoechea & Strean, 2007) is attracting an ever-increasing share of study and research in recent times.

Burnett (2005) highlights the fact that significant others have an extensive influence on an athlete's continued involvement in sport, with this influence extending as far as assisting these athletes in developing an athletic identity. These findings of Burnett (2005) of the importance of sport and identity development are echoed by the study of Poulsen *et al.* (in press), who regard superior physical ability and skill development in a peer context to be important facets in the development of identity in boys.

In a study on 759 Olympic athletes conducted by Richwald and Peterson (2003), 52% of all the athletes polled identified significant others, such as friends and family (second only to persistence and dedication, 58%) as major influences in their attainment of sporting success. This was followed closely in third place (with 49%) by the role of their coaches. In their study on highly successful college athletes, Morgan and Giaccobi (2006) describe the social support network of successful athletes as consisting of the family, the coach and team mates. Specifically, they found many similarities in the sport developmental/participation stages of their sample and those of Bloom (1985) and Côté (1999) (both these are reviewed later in this chapter).

The benefits and advantages of social support are then identified by Morgan and Giaccobi (2006) as being those of general and identity development, the acquisition of psychological and physical skills, the development of coping skills, beneficial relationships, and the learning of life skills, with Rees and Freeman (2007) pointing to the positive effect that perceived (the knowledge that help and support is available) and received (the actual receiving of help or support in a specific circumstance) social support have not only on the self-confidence, but also on the stress levels of athletes. It was found that while both types of social support are beneficial, that received support was more so and contributed more to the athlete being able to cope with stress.

Therefore, as the introduction to this section confirms, the major social support structures in the life and development of an athlete can be separated to be those of; 1) parental roles and support; 2) peer interaction and support, and; 3) the interaction between athletes and their coaches. Each one of these will be addressed in the following sections.

#### 4.4.2.1 Support and role of parents

Parents have an integral role to play in the persistence and success in sport (Bloom, 1985; Côté, 1999; Spamer, 1999; Brustad *et al.,* 2001; Gould *et al.,* 2002, 2006; Côté *et al.,* 2003; Singh, 2005; Wolfenden & Holt, 2005; Williams & Richardson, 2006; Gustafson & Rhodes, 2006; Unknown Author, 2007g) with the family having been found to be the first and most lasting influence that stimulates sport involvement and persistence in the child, with this effect lasting until adolescence (Lau *et al.,* 2005). In the rather eye-opening study of Rowley and Graham (1999) it was found that parental influences have a major effect on the sport participation and socialisation practices and progress of children.

In this study (Rowley & Graham, 1999) it was found that children from lower socio-economic groups are less represented in sports such as gymnastics, tennis, swimming and football. Their study also found *"…the existence of 'sports families' who share common characteristics"* such as *"…parental participation in sport and intact parental marriage"* (Rowley & Graham, 1999:127). Gustafson and Rhodes (2006) also found a positive correlation between socioeconomic status and the participation in sport and physical activity, whereas their findings regarding parental involvement in sport and the influence thereof on their children's involvement in sport were ambiguous.

The influence of fathers (Jodl *et al.,* 2001) and mothers (Papaioannou *et al.,* in press) have been found to be significant. Tangible and financial support, such as the attendance of sporting events and the buying the equipment needed for sport participation that fathers generally provide were found to have a significant impact in the development of talent in children. The specific sport socialisation role of the father is also notable (Jodl *et al.,* 2001).

Contrary to the relatively insignificant impact of the role of the mother found in the study of Jodl *et al.* (2001), Papaioannou *et al.* (in press) attribute great importance to the role of mothers in developing goal orientations as well as in emphasising a climate of learning in which the child can develop. While some, and in certain instances, significant father-son and mother-daughter influences were found, the overall consensus from Gustafson and Rhodes (2006) in this regard are that these influences are at best unclear.

Unfortunately, as Sellers (2003) points out, while family can be of great support and importance to athletes, they can also be of the biggest stumbling blocks. While Sellers (2003) refers specifically to familial hindrance in the competitive environment, there are also examples of how parents become too involved in the sporting careers of their children (Gould *et al.,* 2006). Singh (2005:84) sketches the scenario of "extreme parents" where these parents are guilty of *"…over-identifying with their children's participation or success in sport"* and who are then further found to be living *"…vicariously through their children."* Often, these parents' self-worth is based on their children's success on the sport field. A mutual and obviously problematic relationship potentially rears itself when the children of these parents believe that their parents will only remain interested in them if they persist in sport or continue to be successful.

Another problem associated with this wrong approach to sport and parental involvement in sport is that of unfit and often violent behaviour of adults (parents) at school and other sporting events. Singh (2005:95) tables a collection of *"Incidents of* *youth sport-related violence in South Africa"* between 1997 and 2003. This list does not make for good reading! Wuest and Bucher (2006) in turn refer to an incident in 2000 in youth ice hockey in America where one parent beat another parent to the point of hospitalisation. The victim subsequently died and the attacker was sentenced to between six to ten years in a state prison.

These are admittedly extreme examples of the detrimental affect of extreme parental involvement. In general and as has been shown, parental involvement is of great and immeasurable benefit to young and developing participants in sport. In the last section of this chapter, the specific developmental models of talent and excellence (Bloom, 1985; Ericsson *et al.,* 1993; Côté, 1999; Button & Abbott, 2007; Côté *et al.,* 2007) are presented. It must be noted that in some of these models, parents play an integral, albeit often changing role (Côté *et al.,* 2003; Wolfenden & Holt, 2005) throughout the progression and development of talent.

#### 4.4.2.2 Peer interaction and support

Friendship and peer interaction has been less studied than most other social interactions within a sporting context (Smith, 2003a; Ullrich-French & Smith, 2006; Papaioannou *et al.,* in press), but this does not preclude the fact that this relationship setting is also of vital importance in sustained sport participation and the development of talent.

Lau *et al.* (2005) mention that while the family exerts the biggest influence on sport participation until adolescence, subsequent to adolescence it is the peer interactions and relationships that have the biggest impact and effect on sustained sport participation. Papaioannou *et al.* (in press) highlight the complex nature of peer interactions in sport, since perceptions of friendship change over time and are often unstable during childhood.

Higher levels of physical activity and participation motivation have been encountered in youths aged twelve to fifteen years when their perceptions of both friendship with and acceptance from peers are high (Ullrich-French & Smith, 2006). Smith (2003a) mentions the possible role of peer relationships in the inevitable transitions that individuals undergo when entering sport, when increasing their involvement in competitive sport and also when exiting the competitive sport milieu, and proceeds to ask hypothetically whether peers make such transitions easier or more difficult, and whether they facilitate or hinder these transitions.

And, almost in answer to this question of Smith (2003a), Vazou *et al.* (2006:216) make the statement that *"…the peak years of sport involvement for young athletes coincide with the developmentally dependent tendency for youngsters to rely on peer informational sources in assessing personal competence."* Vazou *et al.* (2006) further states that in children and adolescents, strong social bonds with peers can promote sustained interest in sport.

So, can it be assumed from these answers that healthy peer relationships are advantageous and facilitate the transitions of Smith (2003a) and that unhealthy relationships hinder these transitions? From the evidence presented, this certainly seems to be the case.

From this small cross-section of literature on the issue, peer influences seem to be of the utmost importance within sport (Smith, 2003a; Lau *et al.,* 2005; Ullrich-French & Smith, 2006; Vazou *et al.,* 2006; Papaioannou *et al.,* in press) and within the transitional contexts related to sport (Smith, 2003a).

#### 4.4.2.3 Interactions between athletes and coaches

The final meaningful relationship that contributes to that of the development of talent and excellence in sport is that of the coach and the athlete. The athlete-coach relationship is critical to the process of coaching and sport development, not least of which because the nature of this relationship is likely to determine not only the success attained by the athlete but also the sustained participation in sport of the athlete (Bloom, 1985; Jowett & Meek, 2000a, 2000b; Côté *et al.,* 2003; Jowett &

Cockerill, 2003; Philippe & Seiler, 2006; Poczwardowski *et al.,* 2006; Vazou *et al.,* 2006; Williams & Richardson, 2006; Omar-Fauzee *et al.,* 2007; Papaioannou *et al.,* in press).

The best definition used to describe the athlete-coach relationship and mutual dependence is that proffered by Philippe and Seiler (2006:160) who say that the mutual dependence between both parties is framed by the *"…athlete's need to acquire the knowledge, competence and experience of the coach, and in the coaches' need to transfer their competences and skills into performance and success. Therefore athlete and coach develop a partnership or a professional relationship and they spend a great deal of time together in order to ultimately achieve performance success."*

Therefore, in the preceding discussion, the interaction between all the role-players and significant others in the life of the sports participant has been shown to be critical. They affect the sustained participation and development of the athlete and can ultimately contribute to the success that the athlete achieves. What follows now is an evaluation of specific developmental models, theories and approaches that are the most prominent in literature, along with some recent models of note.

### 4.4.3 Specific talent and expertise developmental models for sport

As stated earlier and important to note at this juncture once again, every talent and expertise development model contained in this sub-section has as their central tenet the fact that there are familial and parental influences that guide and assist in the development of excellence. Ranging from the provision of substantial resources in the form of the provision of equipment and access to facilities (Ericsson *et al.,* 1993) to the initial major influence of parents with the subsequent diminishing of this influence as the children progress and gain more proficiency in the sport (Bloom, 1985; Côté, 1999), the role of parents cannot be denied.

Another point that demands explanation at this time is the selection of models to include in this study and sub-section. For the sake of clarity and space only the most widely cited and quoted models and theories in the literature have been included in this sub-section, along with more recent models of interest.

#### 4.4.3.1 Characteristics of Talented Performers (Bloom, 1985)

The model of Bloom (1985) is widely regarded as a (the) seminal work on the development of talent and expertise and sport and physical endeavours and is cited, included, discussed and incorporated in numerous studies, as is evidenced by a small collection (Régnier *et al.,* 1993; Van Rossum, 1995; Brown, 2001; Durand-Bush & Salmela, 2001; 2002; Wolstencroft, 2002; Côté *et al.,* 2003, 2006, 2007; Soberlak & Côté, 2003; Baker *et al.,* 2003c; Wolfenden & Holt, 2005; Williams & Richardson, 2006; Button & Abbott, 2007) incorporated here.

In this research, Bloom (1985) interviewed 120 individuals, including Olympic swimmers and top level tennis players. From the findings of these interviews, the process of talent development was described as one that requires extensive financial resources and that takes time. This process is also mentally taxing for the individual under development as well as for other members of the family (Bloom, 1985; Van Rossum, 1995).

Bloom (1985:509) says that no individual has *"…reached the limits of learning in a talent field on his or her own. Families and teachers were crucial at every point along the way to excellence."* Therefore, in his findings he identifies three role players in the development of talent, i.e.: the athlete themselves, the coach and the parents. He further identifies three stages in the career phases that the athletes progress through with specific characteristics in each phase.

While Bloom (1985) did not originally present his findings in table form, studies such as Régnier *et al.* (1993) and Van Rossum (1995) consolidated and tabled the findings, and it is these studies, along with the publication of Brown (2001), that have been used to present these consolidated contributions in the table hereafter.

**Table 4.2: Characteristics of talented performers (and their mentors and parents) at various stages of their careers (Bloom, 1985).**

| **Individual** | **←** | **Career Phase** | **→** |
|---|---|---|---|
| | **Initiation/ Early Years** | **Development/ Middle Years** | **Perfection/ Later Years** |
| **Performer/ Athlete** | Joyful, playful, excited, "special" | "Hooked," committed | Obsessed, responsible |
| **Mentor/ Coach** | Kind, cheerful, caring, focussed on process | Strong, respecting, skilled, demanding | Successful, respected/feared, emotionally bonded |
| **Parents** | Shared excitement, supportive, encouraging, positive | Made sacrifices, restricted activity | Limit roles, provide financial support |

*Adapted from Régnier et al. (1993:296), Van Rossum (1995:46) and Brown (2001:61)*

#### 4.4.3.2 Theory of Deliberate Practice (Ericsson *et al.,* 1993)

The Deliberate Practice Theory of Ericsson *et al.* (1993) is a highly nurturist/environmental model that holds that the development of expertise and expert performance in a multitude of domains, including sports, is dependent mainly on extensive and deliberate practice (Du Rand-Bush & Salmela, 2001; Starkes *et al.,* 2001; Nordin *et al.,* 2006; Ollis *et al.,* 2006; Côté *et al.,* 2007; Hodges *et al.,* 2007; MacMahon *et al.,* 2007). It is according to the main proposals of this theory that the arguments were made by its first author and main proponent (Ericsson, 2003b, 2007a, 2007b) earlier in this chapter that all limitations can be overcome by proper, deliberate and focussed practice. These arguments also reject the genetic contribution to excellence in sport. In truth, this theory should be seen more as an expertise development theory as a opposed to a talent development theory, due to this theory's refusal to acknowledge the genetics (other than hesitantly acknowledging body length and a predetermination to motivation) in the development of high ability.

The seminal Theory of Deliberate Practice of Ericsson *et al.* (1993) has as its central thesis that those who exhibit expertise or excellence in a domain consistently engage in deliberate and specific practice activities and efforts that are well defined and structured, with this practice serving the purpose of improving specific important aspects of performance through continuous repetition and subsequent improvement (Ericsson *et al.,* 1993; Ericsson & Lehmann, 1996; Durand-Bush & Salmela, 2001; Johnson *et al.,* 2006; Ericsson, 2004, 2007a). In so doing, these individuals continually and consistently improve those aspects that are critical to excellence and superior performance in the task

Vital to the process of deliberate practice is that the practice and training is at a level of difficulty that challenges the performer and that detailed and immediate feedback, as well as the chance for error correction is provided for further improvement. Also, practice alone tended to be most relevant and effortful (Ericsson *et al.,* 1993; Ericsson & Lehmann, 1996; Durand-Bush & Salmela, 2001; Ericsson, 2004, 2007a; Ward *et al.,* 2004; Johnson *et al.,* 2006; Hodges *et al.,* 2007; MacMahon *et al.,* 2007).

This theory also supports the premise of Simon and Chase (1973) that it takes a decade (or ten thousand hours) of deliberate and specific practice to reach excellence or expert levels of performance in a domain (Ericsson *et al.,* 1993;

Ericsson & Lehmann, 1996; Baker *et al.,* 2003a, 2003c; Ward *et al.,* 2004; Côté *et al.,* 2007).

There are certain notable constraints inherent to this theory and to the subsequent attaining of excellence and expert performance. These are:

1) Initially, there is no financial benefit, and substantial resources in the form of training equipment, as well as access to facilities are required for deliberate practice (Ericsson *et al.,* 1993; Durand-Bush & Salmela, 2001; Baker *et al.,* 2003a, 2003b, 2005; Ward *et al.,* 2004).

2) A high degree of effort is required, since deliberate practice entails significant physical and mental demands (Ericsson *et al.,* 1993; Starkes *et al.,* 2001; Durand-Bush & Salmela, 2001; Baker *et al.,* 2003a, 2003b, 2005; Janelle & Hillman, 2003; Summers, 2004; Ward *et al.,* 2004; Hyllegard & Yamamoto, 2005; Côté *et al.,* 2007; MacMahon *et al.,* 2007).

3) Deliberate practice is not an enjoyable activity and therefore requires strong motivation to persist in this process (Ericsson *et al.,* 1993; Starkes *et al.,* 2001; Durand-Bush & Salmela, 2001; Baker *et al.,* 2003a, 2003b, 2005; Janelle & Hillman, 2003; Summers, 2004; Ward *et al.,* 2004; Baker *et al.,* 2005; Hyllegard & Yamamoto, 2005; Côté *et al.,* 2007; MacMahon *et al.,* 2007).

As could be expected, aspects of the Deliberate Practice Theory of Ericsson *et al.* (1993) have been queried, with various studies aimed at reviewing certain methods and theoretical assumptions of this theory (Starkes *et al.,* 2001; Baker *et al.,* 2003a; Ward *et al.,* 2004; Hodges *et al.,* 2004, 2006).

Davids (2000) and Ward *et al.* (2004) in particular highlight the problem with the premise that it takes a decade or ten thousand hours of deliberate practice to reach elite status in sport. While some research supports and validates the findings of

Ericsson *et al.* (1993) in other domains, specific research examining this theory in the domain of sport in general and team sports in particular has been limited.

Studies done on sports such as figure skating (Starkes *et al.,* 1996), wrestling (Hodges & Starkes, 1996), soccer (Helsen *et al.,* 1998, 2000) and field hockey (Helsen *et al.,* 1998) show strong correlations between total practice hours and high levels of performance in these sports types, with these afore-mentioned studies also noted in other studies (Starkes *et al.,* 2001; Baker *et al.,* 2003a, 2003c; Ward *et al.,* 2004; Hyllegard & Yamamoto, 2005; Hodges *et al.,* 2006, 2007; Johnson *et al.,* 2006; Côté *et al.,* 2007; French *et al.,* 2007). It is however with other issues and theorisations there have been certain discrepancies.

Baker *et al.* (2003a) and Ward *et al.* (2004) note that there are discrepancies relating to the type of practice (alone vs. team) where studies (Hodges & Starkes, 1996; Helsen *et al.,* 1998, 2000) have found that time spent in team practice is actually more significant. In contrast to Ericsson *et al.* (1993) who focused on practice when alone, Helsen *et al.* (1998; 2000) stated that while the field hockey and soccer athletes participating in their study had performed approximately 10 000 hours of training at the time of testing, they (the authors) took all forms of practice and training into consideration. Specific findings of Helsen *et al.* (2000:732) were that *"A positive linear relationship was found between accumulated individual plus team practice and skill."*

Other perspectives such as the non-domain-specific nature and applicability of the Deliberate Practice Theory (Hodges *et al.,* 2004; Ward *et al.,* 2004), effort in practice (Hodges & Starkes, 1996; Starkes *et al.,* 1996; Ward *et al.,* 2004), enjoyment in practice (Starkes *et al.,* 2001; Ward *et al.,* 2004; Hyllegard & Yamamoto, 2005), gender (Hodges *et al.,* 2004, 2006, 2007), mental imagery and deliberate practice (Nordin *et al.,* 2006) and the relationship between deliberate practice and age (Hodges *et al.,* 2006) have been noted and investigated with some findings complementary and others contrary to those originally proposed by Ericsson *et al.* (1993).

What is clear is that persistent, specific and deliberate practice that benefits the development and constant improvement of all the physical and skill specific aspects required for superior performance in sport is of the utmost importance (Baker & Davids, 2007b). From the research presented, it is also clear that this Theory of Deliberate Practice has many proponents and has provided the impetus and influence for a great many studies into the nature and influence of deliberate practice and the role this plays in the development of excellence and expert performance in a number of domains, including sport.

It would also be a fair observation to say that the theory of deliberate practice has greatly influenced the study of expert performance in sport, as the representative studies included (Starkes, 2000, 2003, 2007; Côté *et al.,* 2003, 2007; Deakin & Cobley, 2003; Hodges *et al.,* 2004, 2006, 2007; Hyllegard & Yamamoto, 2005; Williams & Ward, 2007) that focus on various aspects, applications and discussions of and surrounding deliberate practice attest to.

#### 4.4.3.3 Stages of Development in Sport (Côté, 1999)

Côté (1999) investigated the role of the family in the development of talent in sport and had as the framework for this study the theory of deliberate practice of Ericsson *et al.* (1993). Through his investigation, Côté (1999) could identify three phases/stages that closely coincide with the phases proposed by Bloom (1985), but that differed in two aspects, namely their sport-specificity and length of time.

The differences in the two studies, as stressed by Côté (1999), are that Bloom's (1985) study included subjects from many different domains, whereas Côté's (1999) study focused primarily on sport. Also, Bloom's (1985) study considered the career span of the subjects, while Côté's (1999) investigation focused on the ages of six to approximately eighteen years of age.

The specific phases and parental involvement within these phases will be presented hereafter:

1) Sampling years Côté (1999:401).

This stage spans the ages of six to thirteen years and emphasises the involvement of the youngster in a number of sports and activities. Parents stimulate the child's initial interest in sport and provide enjoyable participation opportunities for their children. Focus is not on intense training but rather on excitement and fun. Other notable aspects in this phase are participation opportunities in various sports for all the children in the family and the apparent recognition of a gift or ability in a specific child (Côté, 1999).

2) Specialising years (Côté, 1999:404).

Ranging from the ages of thirteen to fifteen years, this stage is characterised by a narrowing of focus on one or two sports. A pertinent feature of this phase is the increased emphasis from parents on school achievement over sport achievement. In this phase parents are found to encourage the child to focus more on achievement in school and sport as opposed to having part-time work (Côté, 1999).

Other significant features of this phase are; 1) that the parents make considerable time and money commitments toward their children's interest in sports; 2) a growing interest in their child's sport participation, and; 3) positive influence of older siblings (Côté, 1999).

3) Investment years (Côté, 1999:408).

This stage stretches from the age of fifteen years and onwards. The overall emphasis of this stage is that of the child's/adolescent's commitment to achieving an elite level in a single sport or activity (Côté, 1999).

Other notable features of this phase include; 1) the parents also showing an increased investment in the child's sport of choice; 2) parents assisting the athlete to overcome any setbacks that may hinder progression in training and also in assisting their children in dealing with failure, pressure, fatigue, injury etc.; 3) the possible demonstration of different behaviours from parents toward each of their children regarding time and money, and; 4) the possible arising of jealousy or bitterness from the twin or younger sibling as a result of perceived unfairness in treatment (Côté, 1999).

Another feature of this theory was the proposal of the concept of "deliberate play" as opposed to the concept of "deliberate practice" championed by Ericsson *et al.* (1993). The main differences between deliberate play as opposed to deliberate practice is that deliberate play is done for its own sake with immediate rewards and where the rules of the original game are adapted to the immediate environment. As opposed to deliberate practice, deliberate play is flexible, enjoyable and done for intrinsic reasons (Côté, 1999; Côté *et al.,* 2003, 2007).

#### 4.4.3.4 Developmental Model of Sport Participation (Côté *et al.,* 2007)

The Developmental Model of Sport Participation (DMSP) can be regarded as a follow-on from the original model of the Stages of Development in Sport of Côté (1999) by including the three originally proposed stages of sampling, investment and specialising, but by further adding a recreational phase as another possible alternative that can be explored in sport participation. Another observable feature of this model is that the issue of early specialisation in sport is addressed.

In this model it is suggested that that the child samples various sports and actively participates in deliberate play activities from the ages of six to twelve years (early diversification). This favourably influences the socialisation of the child and strengthens the persistence in sport. It also assists in the possible attainment of excellence and elite status in sport (Abernethy & Côté, 2007; Côté *et al.,* 2007).

It is also proposed that early specialisation and deliberate practice, while also possibly leading to elite levels of performance, has as an associated disadvantage higher youth dropout rates in sport (Watts, 2002; Baker, 2003; Abernethy & Côté, 2007; Côté *et al.,* 2007) with concerns that children who are specialising at an early age are unable to cope mentally and physically with the demands that accompany intense training (Watts, 2002; Button & Abbott, 2007). Others, such as Wolstencroft (2002) and Abbott *et al.* (2007) are also against early specialisation and say that this can lead to a limiting of overall skill and ability development with negative consequences for the child. As stated in chapter one, this study endorses the views of the early diversification (late specialisation) and maintains a view that is against that of early specialisation.

What follows below is the DMSP model. Take note of the early specialisation as well as the recreational probable outcomes.

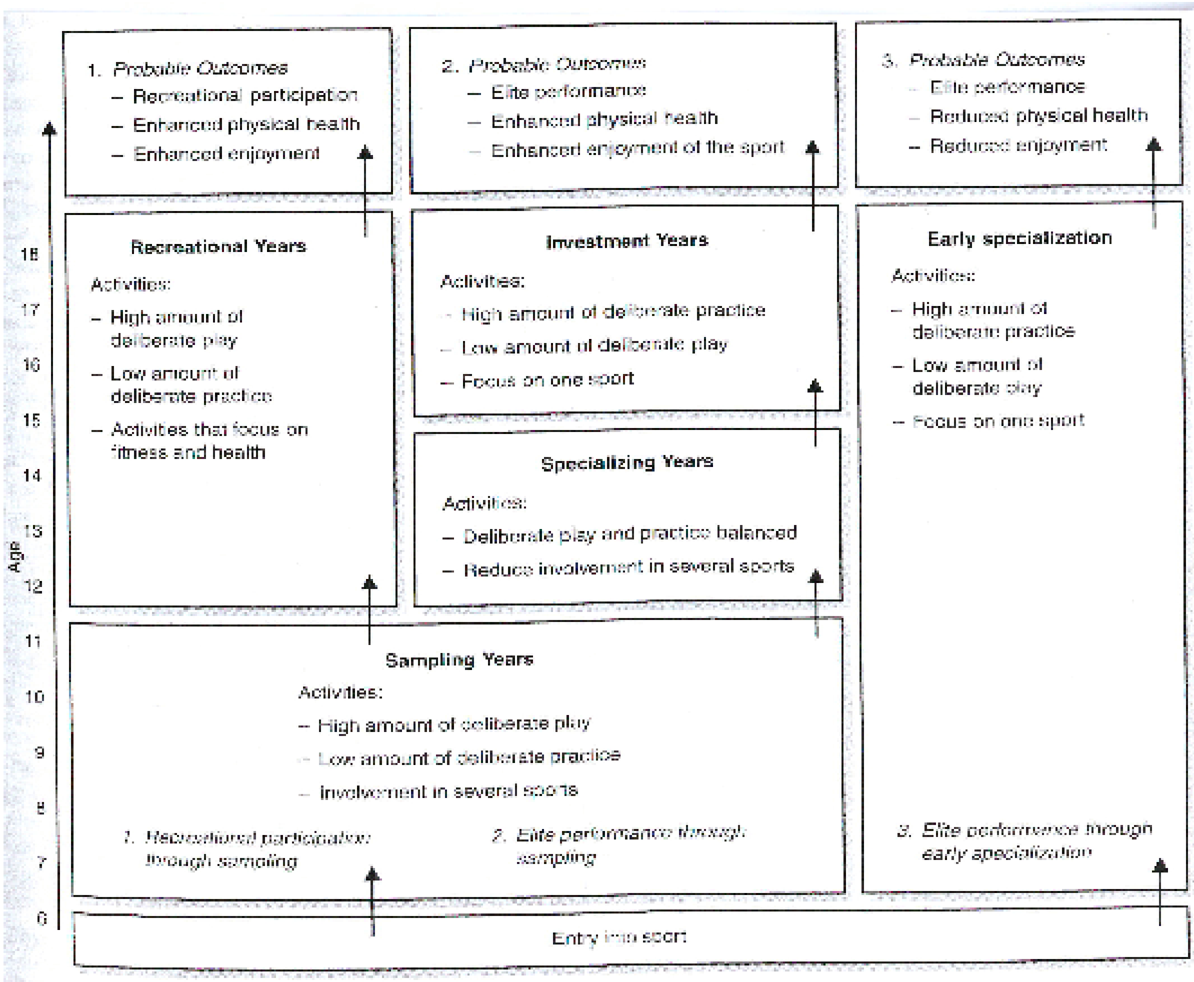


**Figure 4.1: Developmental Model of Sport Participation (Côté *et al.,* 2007:197)**

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### 4.4.3.5 Stages of Development (Button & Abbot, 2007)

The final model to be included in this section is that of Button and Abbott (2007). The author's of this model argue for the importance of talent identification and development, with the focus largely on the development of talent. In an adaptation of the models proposed by Bloom (1985) and Côté (1999), Button and Abbott (2007) propose a model highlighting the stages of development that consist of; 1) an initiation stage transitioning to; 2) a development stage transitioning to; 3) a mastery stage that finally transitions to; 4) a maintenance stage. While not providing specific ages at which these stages either commence or transition to the next stage, it is clear that according to this model, talent identification can play a role in the greater talent development process.

Button and Abbott (2007) note that one of the aspects of Bloom's (1985) work was that talent has an evolutionary component as opposed to a sole genetic component and that the environment, such as skilled coaches and the like play an important role in the progress of talented youngsters. Therefore, development is prioritised. The realisation of the need to create an ideal training environment, so that young and talented athletes can improve and progress to the best of their abilities is an increasingly real consideration. As previously shown, sport organisations around the world have limited financial and other resources and need to optimally apply these financial resources to effectively and adequately identify and develop the talent they have (Morris, 2000; Williams, 2000; Williams & Reilly, 2000b; Abbott & Collins, 2002, 2004; Pearson *et al.,* 2006; Button & Abbott, 2007). There is also an increasing trend in creating elite academies for youngsters (Williams & Richardson, 2006; Button & Abbott, 2007).

This specific model has been included in previous attempts (Abbott & Collins, 2004; Abbott *et al.,* 2005) at combining talent identification and development into one model. The proposed model of Button and Abbott (2007) follows hereafter.

| Initiation Stage | Transition | Development Stage | Transition | Mastery Stage | Transition | Maintenance Stage | Transition |
|---|---|---|---|---|---|---|---|
| • Participation Opportunities<br>• Positive Family Support & Encouragement<br>• Caring Coach Orientation<br>• Fundamental Skill Development<br>• Etc. | Athlete Identify Developed Performance | • Technical coaching<br>• Family Commitment<br>• Increasing Competitive Success<br>• Recognition of Talent and Achievements<br>• Etc. | Sport Prioritised | • High Quality Competitive Training<br>• Additional Financial Support<br>• Collaborative Coach/Athlete Decision Making<br>• Etc. | World Class Performance at Senior Level | • Maintains Best Performance Focus<br>• Develops an Effective System for Dealing with Increase Demands<br>• Etc. | **Consistent World Class Performance** |

→ **GETTING THERE** → **STAYING THERE**

**Figure 4.2: Button and Abbott's (2007:87) Stages of Development previously identified within sport (adapted from Bloom, 1985 & Côté, 1999)**

*Adapted from Button & Abbott (2007:87)*

## 4.5 SUMMARY AND APPLICATION TO TALENT IDENTIFICATION AND DEVELOPMENT

The findings and arguments that have been presented in this chapter are the most enduring and as well as the most recent that could be found within the literature pertaining to the concepts of physical perspectives, maturation, nature versus nurture and the development of talent.

This discussion serves as a summary of this chapter and will focus on the following issues:

1) Physical perspectives and their role within talent identification. This will also include maturation and the relative-age effect.

2) An orientation of this study's perspective and stance on the nature versus nurture debate and the possible role that this plays in talent identification.

3) An orientation of this study's perspectives regarding the development of talent and the role that this plays in talent identification.

### 4.5.1 Physical perspectives and talent identification

From the discussion that was presented surrounding the issue of physical perspectives in talent identification it is clear that the current talent identification approaches in use that focus on the physical/physiological and anthropometrical aspects and perspectives of sport are effective (Aitken & Jenkins, 1998; Hoare, 1998; Pienaar *et al.,* 1998; Nieuwenhuis *et al.,* 2002; Spamer & Winsley, 2003b; Falk *et al.,* 2004; Van Rossum & Gagné, 2005; Gabbett *et al.,* in press)

These talent identification approaches and practices are successful in spite of the previously noted aspects of development. It has been shown that anthropometrical, physical and physiological variables are developmentally relatively unstable throughout adolescence (Ackland & Bloomfield, 1996; Williams & Reilly, 2000b;

Abbott & Collins, 2002, 2004; Wolstencroft, 2002; Abbott *et al.,* 2005; Vaeyens *et al.,* submitted) and that there is a decreasing importance of kinanthropometrical influences on performance during this time (Pienaar & Spamer, 1996a; 1998; Abbott & Collins, 2002; Nieuwenhuis *et al.,* 2002; Vaeyens *et al.,* submitted).

It is the view of this study that the status quo in this regard be maintained until another, better or more effective approach can be presented. Quite obviously, psychological and skills tests are a necessity (see chapters five and six in this regard) and that a combined approach addressing all these issues and perspectives is the best and most holistic option. A multivariate and multidisciplinary approach is by far the most ideal for talent identification and development. And, there are cases where this approach is found. Two South African examples of this multidisciplinary approach incorporating psychological variables in testing and evaluation are those of Hare (1999) on rugby and Nieuwenhuis *et al.* (2002) on hockey, with the latter study successfully including psychological variables in the resulting prediction function.

The considerations of early maturation and the relative-age effect are issues that will always be present since one cannot alter the genetic and developmental processes inherent to maturation. Nothing can be done about the date of birth of individuals with this having an impact on talent identification and subsequent development of sport expertise and excellence. It has been shown that those benefiting from this relative-age effect are consistently more represented in elite teams and subsequent development programs, with these individuals more likely to be successful in sport later on (Musch & Grondin, 2001; Vaeyens *et al.,* 2005a; Côté *et al.,* 2007; Medic *et al.,* in press; Vaeyens *et al.,* submitted). And, since talent identification and selection is based on identifying the most successful individuals in an age-group, the significant impact of early maturation and the relative-age effect can be assumed. It must once again however be emphasised that this initial advantage of early maturation is often found to diminish in later years.

And, while the relative-age effect has a role to play in selection, there is the added consideration of the birth-place effect in sport, although this phenomenon arguably does not impact upon the identification of talent, but more upon the development thereof. In this birth-place effect, it has been found that there are numerous developmental benefits relative to the size of the city in which individuals live. For example, some studies have found that elite players are more likely to come from rural areas (Côté *et al*., 2007), while others have found that individuals living in more densely populated urban environments have the luxury of testing themselves against team mates or competitors that are of the same demographic, i.e.: size, age and ability (Côté *et al*., 2006). On the other hand, it has been argued that the development of sport expertise and excellence can be promoted in rural areas due to the opportunities that these children have to interact and play with adults and older children, allowing for more experimentation with different types of sports and activities (Côté *et al*., 2003, 2006; Soberlak & Côté, 2003). Other aspects of rural areas such as access to open space, fewer leisure alternatives and less safety issues are also seen as being beneficial to development (Côté *et al*., 2007).

In fact, the specific findings of Côté *et al*. (2006) are that professional athletes are more commonly from cities of less than 500 000 and less often hail from cities of 500 000 and above. The findings published by Baker and Logan (2007) showed some disparity (as opposed to Côté *et al*., 2006) regarding the size of city and the chances of individuals to be drafted by the National Hockey League (NHL), but they found a birth-pace effect nevertheless, whereas Tsimeas *et al.* (2005) found no evidence of this birth place effect in their study on 360 boys and 247 girls of an even urban and rural mix.

### 4.5.2 Nature versus nurture

This issue and debate was discussed at length earlier in this chapter. It is quite obvious that this issue will probably never be adequately resolved and as Starkes (2007:89) so eloquently states in the 2007 special issue of the International Journal of Sport Psychology addressing the Nature versus Nurture debate, *"…I can't help* *wondering whether Galton's (1883) discussion of the role of nature and environment is any less relevant with regard to these papers than it was to Victorian readers"* of the time when he first published his findings.

From the literature presented it seems as if, to be fair, the nature proponents (Klissouras, 2001; Geladas *et al.,* 2007; Klissouras *et al.,* 2007) allow for a greater interaction between their position (genotypes imposing limitations on phenotypes) and the influence of practice, training and development than do the nurture advocates (Ericsson *et al.,* 1993, 2005; Howe *et al.,* 1998; Ericsson, 2003a, 2003b, 2007a, 2007b) who, for their part, find no (or very little) evidence of genetic influence and attribute all excellence to practice and the environment. Obviously, the centrist (Starkes, 2007) and the interactionist proponents (Simonton, 1999, 2001, 2005, 2006; Van Rossum & Gagné, 2005; Morgan & Giaccobi, 2006) adopt a healthy stance that accepts the effect of genetics, training and the environment on the development of talent and excellence.

Some recent findings will undoubtedly contribute further to this ongoing debate. In their study on elite and sub-elite swimmers, Johnson *et al.* (2006) found that some elite swimmers reached elite status quite a while before completing the mandatory 10 000 hours of practice originally proposed by Ericsson *et al.* (1993), whereas certain sub-elite swimmers all completed 10 000 or more hours of practice while still remaining at their level of achievement or attainment. It is hinted at by the researchers that 'other factors' such as possible genetic influences lead to elite performance. Since no explicit view is proffered by these researchers, two are offered by this study in the form of hypothetical questions: could it be that genetics and heredity contribute to the ability to train more effectively and the rate at which excellence is developed and acquired, as some have suggested? Furthermore, could it just be possible that certain genes have an amplifying and catalytic effect on training, and vice-versa?

These questions are by no means broad-shots in the dark; views of a similar nature are held by both Baker (2007) and Simonton (2007). Baker (2007) is of the opinion that while deliberate practice is a necessary function of elite attainment, he feels that it is definitely not sufficient to elite attainment, whereas Simonton (2007) claims that it is the genetic endowment of an individual that influences the rate at which expertise and excellence is acquired (in tacit agreement with Johnson *et al.* 2006). He is however further undecided as to whether genetic makeup imposes upper or lower limits on the attainment of excellence.

Perhaps, in conclusion of this section the views of Klissouras (2001), Gagné (2007) and Klissouras *et al.* (2007) should be reviewed again regarding the influence of nurture. According to Klissouras (2001) and Klissouras *et al*. (2007), genes and genetics cannot be seen as directly influencing the destiny of the individual. They further summarise their views quite succinctly by stating that; 1) genes do not act independently of other factors; 2) epigenetic influences are notable; 3) phenotypes do not develop without training and environmental forces, and; 4) that it takes a great amount of hard work and commitment to realise your genetic potential. Their unwavering stance, however, is that it is an inescapable fact that genotypes set limits to phenotypes with numerous of their own and other studies supporting of this fact.

Gagné (2007) is less charitable; he seems to be of the opinion that not much progress has been made since Howe's *et al.* (1998) landmark article defining and then delimiting talent. Further, there does not seem to be much change to his views that he held and aired in his response (Gagné, 1998) to Howe's *et al.* (1998) original assertions in which he provided as evidence of innate talent the example of Sarah Chang, a five year old violin prodigy. Gagné's (2007) views are those of vehement disagreement with the views of both Howe *et al.* (1998) and Ericsson *et al.* (2007a).

Therefore, are elite sports performers and participants made, as some propose (Ericsson *et al.,* 1993, 2007a, 2007b; Ericsson, 2003a, 2003b, 2007a, 2007b) or born, as others contend (Gagné, 1998, 2007; Klissouras, 2001; Geladas *et al.,* 2007; Klissouras *et al.,* 2007)?

This view adopted by this study, in agreement with Hopkins (2001), is that they're first born *and then* made. Or, more specifically, upon conception, genetic potentialities and abilities are transferred. Upon birth the general development of these potentialities and abilities is commenced and through specific training, deliberate practice and exposure to an optimal, supportive and stimulating environment, these potentialities and abilities are developed, refined and retained.

The impact on talent identification is therefore that, in assuming the afore-mentioned views, certain abilities, like the concept of giftedness as proposed by Van Rossum and Gagné (2005) are identifiable at young ages and that through proper guidance, play, practice and refinement these abilities can be developed into their eventual potentialities, such as the concept of talent, also proposed by Van Rossum and Gagné (2005). This particular proposal is discussed briefly hereafter.

### 4.5.3 Talent development and identification

The developmental models of Bloom (1985), Côté (1999), Côté *et al.* (2007) and Button and Abbott (2007) as well as the Deliberate Practice Model of Ericsson *et al.* (1993) are all models ascribed to by this study, with certain provisos. This study adopts the view of being anti-early specialisation, which is an explicit view held by Côté (1999) and Côté *et al.* (2007) and implied view held by Bloom (1985) and Button and Abbott (2007). Unfortunately, it seems as if early specialisation is a prerequisite of the Deliberate Practice Theory (Ericsson *et al.,* 1993) if the ten year/ten thousand hour rule is to be strictly adhered to.

A possible way of unifying these approaches is to acknowledge that certain sports probably have an early age elite status (ladies gymnastics), but that to adopt the overall view that most sports do not require this early elite-level of specialisation. Furthermore, elite sport attainment is relative to age and circumstance (e.g.: U/16

Craven Week vs. senior provincial or Springbok team) where the ages of the individuals in question may be young but where their overall status in their sport of choice is of a more elite nature than their peers.

If the models under discussion are reviewed (with the exception of Ericsson *et al.,* 1993) it is quite clearly shown that sport participation starts with an introductory, sampling (Côté, 1999; Côté *et al.,* 2007), initiation or early stage/phase (Bloom, 1985; Button & Abbott, 2007) spanning a number of years, after which there is an associated narrowing of focus and increase in development (Bloom, 1985; Button & Abbott, 2007) and specialisation (Côté, 1999; Côté *et al.,* 2007). It seems as if this second phase/stage starts roughly at the onset of adolescence and spans a few years until approximately mid-adolescence (Côté, 1999; Côté *et al.,* 2007).

In most of these models, the perfection (Bloom, 1985), investment (Côté, 1999; Côté *et al.,* 2007) and mastery (Button & Abbott, 2007) phase/stage then commences, which allows for a sole or narrow focus on one sport of choice. Côté *et al.* (2007) allow for a recreational phase/stage (as an alternative to specialising), while Button and Abbott (2007) include a subsequent maintenance phase/stage and it is this that sets them apart from the other two models under review.

And while caution needs to be maintained when applying these models across the spectrum of all sport participants, considering that successful individuals may or may not necessarily proceed through the specific phases as noted in these models, these models are generally robust in their overall findings and generalisations.

But, what are the implications of these models/approaches to talent identification? Talent identification studies are for the most part successfully performed on children and adolescents, as the examples included (Pienaar & Spamer, 1996a, 1996b, 1998; Pienaar *et al.,* 1998, 2000; Hare, 1999; Booysen, 2002; Nieuwenhuis *et al.,* 2002; Van Gent, 2003; Spamer and Winsley, 2003a, 2003b; Van Gent & Spamer, 2005; Plotz and Spamer, 2006, Spamer & De la Port, 2006; Elferink-Gemser *et al.,*

2007) more than adequately show. What needs to be acknowledged at all times is the sovereign right and privilege of the individual(s) under review, as highlighted by Spamer (1999), to sample as many other sports as they choose and not to be pressurised in any way to persist in any particular sport, even if they exhibit great potential in the sport under review. This does not preclude from responsible and ethical guidance of the youngsters into the sport in which they have most promise; perhaps a subtle push may in fact be needed to encourage often undecided youth participants to persist in a sport to which they are most suited.

Furthermore, talent identification can constructively contribute to the processes circumscribed in these models and further assist in the transitions in talent development as proposed by Button and Abbott (2007), and even the other models that were reviewed. When considering the most suited model to talent identification; while all the models have certain benefits, the model that can be regarded as most suited to talent development within the talent detection, identification and selection framework is that of Button and Abbott (2007).

In conclusion and as stressed earlier in this sub-section, this study maintains the view that the status quo regarding current practice in talent identification is maintained. This implies a multivariate, multidisciplinary approach to the testing for physical/physiological, anthropometrical, skills and psychological variables. A combined approach addressing and measuring all these perspectives is the best and most holistic option and, when combined with specific developmental models and practices is most constructive and beneficial to all involved, be it the athletes themselves, parents, families, coaches, government, sporting organisations and ultimately society at large.

# CHAPTER FIVE

# TALENT IDENTIFICATION: PSYCHOLOGICAL PERSPECTIVES

## 5.1 INTRODUCTION

The multi-factorial and multi-dimensional nature of sport and rugby, with the associated requirements of excellence within these factors and dimensions has been widely documented (Ericsson & Lehmann, 1996; Brown, 2001; Krüger *et al.,* 2001; Olds, 2001; Nieuwenhuis *et al.,* 2002; Janelle & Hillman, 2003; Elferink-Gemser *et al.,* 2004, 2007; Abbott *et al.,* 2005, 2007; Vaeyens *et al.,* 2006; Ollis *et al.,* 2006; Andrew *et al.,* 2007) both in literature, and in previous chapters, with the physical and developmental aspects of these perspectives reviewed in-depth in chapter four of this study.

Due to this strong consensus that psychological factors and dimensions, in conjunction with the physical factors and aspects of sport and rugby, are of immense value to talented and superior performance in these afore-mentioned endeavours, it is found that these factors and dimensions are, or need to be, increasingly incorporated into talent identification and development protocols and initiatives (Régnier *et al.,* 1993; Hare, 1999; Brown, 2001; Abbott & Collins, 2002, 2004; Abbott & Easson, 2002; Nieuwenhuis *et al.,* 2002; Falk *et al.,* 2004; Abbott *et al.,* 2005, 2007; Lidor *et al.,* 2005, 2007; Button & Abbott, 2007; Elferink-Gemser *et al.,* 2007) to properly adopt a multidisciplinary, multivariate approach to talent identification and development.

It was pointed out in chapter three that in recent times there has been a recognised increase in research into issues of excellence in sport (Starkes *et al.,* 2001; Starkes & Ericsson, 2003; Williams *et al.,* 2003; Abernethy *et al.,* 2005; Williams & Ericsson, 2005; Williams & Hodges, 2005; Hodges *et al.,* 2006; McPherson & Kernodle, 2007; Vaeyens *et al.,* 2007), with an associated increase in calls for the adoption of a multidimensional and multidisciplinary approach (Wrisberg, 1993, 2001; Ward &

Williams, 2003) to the study of expertise and excellence, as well as other related considerations in sport. This increased interest in sporting excellence from a research perspective is confirmed by the parallel increase in focus on issues of excellence in sport from the unique and evolving discipline of sport psychology and the related perceptual-cognitive and perceptual-motor perspectives.

There is a slew of books, volumes, (Singer *et al.,* 1993, 2001; Cox, 1994; Roberts, 2001a; Starkes & Ericsson, 2003; Weinberg & Gould, 2003; Williams & Hodges, 2004; Ericsson *et al.,* 2006; Tenenbaum & Eklund, 2007) texts and studies (Helsen & Starkes, 1999; Gould *et al.,* 2002; Williams *et al.,* 2003; 2004; Abbott & Collins, 2004; Abernethy *et al.,* 2005; Williams, 2005; Williams & Ericsson, 2005; Smith, 2006b; Williams & Ward, 2007) that serve as evidence of this fact.

Therefore it is an accepted and widely researched fact that certain psychological skills, abilities and attributes are needed, used and/or possessed by performers in achieving high levels of performance in elite sport and rugby, as the literature included shows (Potgieter, 1992; Cox & Yoo, 1995; Spamer, 1999; Morris, 2000; Williams & Reilly, 2000b; Brown, 2001; Fourie & Potgieter, 2001; Olds, 2001; Abbott & Collins, 2004; Abbott & Easson, 2002; Gould *et al.,* 2002; Hale & Collins, 2002; Jones *et al.,* 2002, 2007; Williams *et al.,* 2003, 2004; Baker & Horton, 2004; Golby & Sheard, 2004; Abernethy *et al.,* 2005; Nordin *et al.,* 2006; Andrew *et al.,* 2007; Williams & Ward, 2007).

In keeping with the recent trend of increasing multidisciplinary research into sport, and as noted at the start of this chapter, there has of late been an upswing in the number of studies and publications calling for the consideration, as well as actually including these factors alongside the physical aspects, when selecting teams or players, or when performing talent identification and development (Brown, 2001; Abbott & Collins, 2002, 2004; Abbott & Easson, 2002; Nieuwenhuis *et al.,* 2002; Falk *et al.,* 2004; Abbott *et al.,* 2005, 2007; Lidor *et al.,* 2005, 2007; Andrew *et al.,* 2007; Button & Abbott, 2007; Elferink-Gemser *et al.,* 2007), although the importance of psychology in talent development, and the inclusion of tests for psychological variables in talent identification protocols has been noted, suggested and performed in literature (Régnier *et al.,* 1993; Hare, 1999) for some time already.

In fact, it has been suggested by some that psychological skills and abilities are not only of tremendous importance in sport, but that these aspects are, in certain instances, of greater significance and can serve as better predictors of success (Abbot & Collins, 2004; Nordin *et al.,* 2006) or, in conjunction with technical abilities and skills, act as more effective discriminators between more able and less able players (Williams & Reilly, 2000b; Williams & Ward, 2007), than physical, physiological and anthropometrical variables. Abbott and Easson (2002) and Andrew *et al.* (2007) concur that psychological factors are important in identification and selection respectively, and that an integrated approach toward these respective endeavours is needed.

Therefore, it is clear that mental and psychological faculties, skills, attributes and abilities are absolute prerequisites for success in sport and that furthermore, analyses and possible measurement of these faculties, skills, attributes and abilities is important in the process of talent identification if this process is to be all-encompassing and successful in achieving its goal of attaining the highest prediction accuracy as is possible.

### 5.1.1 Background of sport psychology

The field of sport psychology and the associated interest therein has expanded considerably in recent times (Singer *et al.,* 2001; Weinberg & Gould, 2003; Williams, 2005; Smith, 2006b; McPherson & Kernodle, 2007). Interest in and the development of the parent discipline of psychology is certainly not a contemporary occurrence, however. The earliest psychological concepts were apparent from the time of Plato (427 to 347 B.C.) and Aristotle (384-322 B.C.). It is a discipline that has as its origin the striving of man to make sense of the mind-body relationship. Since then, psychological concepts have constantly evolved in step with an ever advancing human kind, but it was the influence of Wilhelm Wundt in 1879 that is regarded as the date of psychology's beginning (Jordaan & Jordaan, 1984, 1998).

Sport psychology, however, is often mistakenly referred to as being a young area of study (Weinberg & Gould, 2003), but, the earliest work can in fact be traced back to the end of the 1800's with Norman Triplett widely regarded as the original groundbreaker in this field. But, the 1960's and 1970's are widely associated as being the era of this discipline's historical emergence and the start of its rise in prominence (Singer *et al.,* 2001; Weinberg & Gould, 2003; Wuest & Bucher, 2006).

Since sport psychology is so intimately linked to the main discipline of psychology, it stands to reason that sport psychology would be directly influenced by the general developments and trends in psychology. This chapter serves to highlight not only the main trends and approaches in the study of excellence in sport from the perspective of sport psychology, but also the major findings, theories and conclusions.

### 5.1.2 Chapter outline

As noted, a number of studies and texts emphasise the different psychological aspects and skills needed to reach elite levels of sport representation. One very helpful study that assigns these aspects and skills into two specific categories is the study of Baker and Horton (2004). They provide this very helpful distinction as to the psychological characteristics of excellence and expert performance in sport when they state that *"…there are common mental characteristics essential to high levels of performance in any sport. Furthermore, these factors can be divided into characteristics necessary for the acquisition of expertise and those necessary for the manifestation (i.e., the demonstration) of expertise"* (Baker & Horton, 2004:216).

This chapter is very much informed by these sentiments and provides a discussion that focuses on 1) the psychological and mental attributes required to *achieve* elite level in sport and rugby, as well as 2) the psychological and mental attributes and (psychomotor) skills that are required to *demonstrate* superior abilities within elite sport and rugby. There are some minor differences, however, in this study's interpretation and further elaboration of the psychological skills and attributes needed for the achievement and demonstration of superior abilities, and the original interpretations of Baker and Horton's (2004). But, valuable guidance has been garnered from their work and aspects such as motivation and others are certainly common ground, as is shown throughout.

*Section one: motivation, commitment and practice*

In sub-section one of this chapter, the psychological and mental attributes and practices needed to achieve elite levels in sport and rugby are reviewed. This involves the concepts of motivation and commitment. The evidence presented from literature is unanimous that these attributes are the overriding considerations pertaining to the achievement of high levels of performance.

Furthermore, in this sub-section the concept of practice in the form of the Theory of Deliberate Practice of Ericsson *et al.* (1993) is briefly reviewed. While this theory was analysed in-depth in chapter four, this review of the theory has been included in this section for the sole the fact that practice can be regarded as the proverbial "golden thread" that runs through high ability and achievement in all domains, most notably sport. Pertinent to its inclusion in this sub-section are the constructs of motivation and the (lack of) enjoyment that this theory highlights as role-players and constraints in the sustenance of participation in deliberate and focused practice.

*Section two: perceptual-cognitive and perceptual-motor skills*

The second sub-section of this chapter deals with the psychological and mental (psychomotor) skills and abilities necessary for the demonstration of excellence or high levels of performance in elite sport and rugby. These include perceptual-cognitive abilities and skills and how these are needed to attain the requisite levels of excellence within a sport. Perceptual-cognitive skills and abilities include those of decision-making, response selection, experience, memory and others that are traditionally factors that come under consideration in the studies of excellence and expert performance in sport.

Also highlighted is the very recent trend (in sporting terms) instigated by the move away from mere cognitive explanations for excellence in sport (rugby) toward the conviction, arising from the ecological psychology and dynamical systems theories, that “cognition free“ perceptual-motor abilities and skills are responsible for excellence and elite performance in sport.

*Section three: mental toughness*

Recent literature highlights factors such as emotional strength and control as being needed for excellence in sport. These and other issues such as self confidence, the control of anxiety, focus and the like are critical for success in elite sport. These factors have been reviewed in this sub-section under the general construct of mental toughness and strength.

*Section four: summary and application to talent identification and development*

In the final sub-section of the chapter, a summary of the preceding discussion is provided followed by a discussion of three important issues.

1) The interrelation of the psychological and mental skills, attributes and abilities mentioned in this chapter. In particular the relevant and possible influence that these skills and abilities have on one another as well as on talent identification and development will be reviewed.

2) A review of the possible incorporation of the Mental Toughness Framework of Jones *et al.* (2007) and the Elite Athlete Development Model of Cooper and Goodenough (2007) into the talent identification and development process.

3) A discussion centering on the possible inclusion of perceptual-cognitive and perceptual-motor (psychomotor) skills tests in the talent identification process.

## 5.2 MOTIVATION, COMMITMENT AND PRACTICE

Motivation is regarded as an important aspect of study (Scanlan *et al.,* 1993a; Murcia *et al.,* 2007b), with extensive research conducted on this concept of motivation in sport and in general (Roberts, 2001b; Cervelló *et al.,* 2007; Roberts *et al.,* 2007; Vallerand, 2007). Motivation has consistently been highlighted as being an (or the most) important factor in the attainment of success and high levels of performance in any sport (Gould *et al.,* 2002; Spamer & Winsley, 2003b; Baker & Horton, 2004; Tranckle & Cushion, 2006; Starkes, 2007; Vallerand, 2007).

As a result of this high level of focus and attention, there have been numerous theorisations and studies on motivation, and one is spoilt for choice regarding a definition of the term, with the term at times described as being ambiguous and overused (Roberts, 2001b, Roberts *et al.,* 2007). In an attempt to solve the problem presented by sheer overabundance, the common issues pertaining to a definition of motivation as highlighted by some recent studies and publications have been identified.

In quoting Cratty (1983), Schuman *et al.* (2005:146) refer to motivation as *"…the factors and processes that impel people to action or inaction in various situations."* Both Vallerand and Rousseau (2001:389) and Vallerand (2007:59) cite Vallerand and Thill (1993) when defining motivation as being *"…the hypothetical construct used to describe the internal and/or external forces that produce the initiation, direction, intensity, and persistence of behaviour."* Roberts *et al.* (2007:3) define motivational processes as *"…the psychological constructs that energize, direct, and regulate achievement behaviour."*

In rugby, Hodge and McKenzie (2002) highlight the crucial role of motivation in propelling the rugby player to excel in the season, in practice and training aspects and game related factors. They further highlight the fact that motivation is both a desire and a drive. This push-pull dualism is central to the definition of motivation for this study. While this study is not trying to reinvent the proverbial "wheel," it has as its goal a definition that most applies to this specific context. This definition can therefore be viewed as a hybrid of the preceding definitions.

For the purposes of this study motivation can be defined as: *the internal or external processes inherent to an individual that lead to persistent, goal directed and deliberate action or actions for the purpose of achieving pre-determined outcomes or end goals.*

Two of the most researched (Mallett & Hanrahan, 2004) and prominent (Murcia *et al.,* 2007b) theories in sport psychology regarding motivation are, 1) the Achievement Goal Theory, and; 2) the Self-Determination Theory. Mallett and Hanrahan (2004) and Murcia *et al.* (2007b) attribute the Achievement Goal Theory to Nicholls (1989) and Duda (1992; 2001) and the Self-Determination Theory to Deci and Ryan (1985; 1991; 2000) and Ryan and Deci (2000), although, according to Roberts (2001b), the Achievement Goal Theory dates back the collaborative work of Maehr and Nicholls (1980), Nicholls (1980), Ames (1984) and Dweek (1986).

When the number of older and more recent studies and texts on motivation in sport is reviewed, it is clear that these two theories enjoy significant support (Duda, 1993; Chantal *et al.,* 1996; Escartí *et al.,* 1999; Brustad *et al.,* 2001; Duda & Hall, 2001; Roberts, 2001b; Vallerand & Rousseau, 2001; Weinberg & Gould, 2003; Baker & Horton, 2004; Coetzee *et al.,* 2005; Vazou *et al.,* 2006; Wilson *et al.,* 2006; Bengoechea & Strean, 2007; Cervelló *et al.,* 2007; Cumming *et al.,* 2007; Roberts *et al.,* 2007; Vallerand, 2007; Amorose & Anderson-Butcher, in press; Papaioannou *et al.,* in press).

Regarding the concept of commitment to sport, the studies of Starkes (2000), Amorose (2001), Brustad *et al.* (2001), Spamer and Winsley (2003b), Wilson *et al.* (2004), Tenenbaum and Hutchinson (2007), Weiss and Weiss (2007) and McCarthy *et al.* (in press) acknowledge the relevance of the Sport Commitment Model of Carpenter *et al.* (1993) and Scanlan *et al.* (1993a; 1993b) wherein certain motivational considerations and their effect on sustained participation in sport are highlighted.

And then of course there is the seminal Theory of Deliberate Practice as proposed by Ericsson and colleagues (1993) regarding the importance of deliberate and sustained practice in the attainment of success and expertise in various endeavours. From the research presented in chapter four, it is clear that this Theory of Deliberate Practice has many proponents and has provided the impetus and influence for a great many studies into the nature and influence of deliberate practice and the role this plays in the development of excellence and expert performance in a number of domains, including sport. Chapter four also noted that it would be a fair assessment of the fact when saying that the Theory of Deliberate Practice has greatly influenced the study of expert performance in sport, as the representative studies that were included (Starkes, 2000, 2003, 2007; Côté *et al.,* 2003, 2007; Deakin & Cobley, 2003; Hodges *et al.,* 2004, 2006, 2007; Hyllegard & Yamamoto, 2005; Williams & Ward, 2007) and that focused on various aspects, applications and discussions of and surrounding deliberate practice, attested to.

### 5.2.1 Achievement Goal Theory

As underlined previously, Roberts (2001b) attributes this theory to the original work of Maehr and Nicholls (1980), Nicholls (1980), Ames (1984) and Dweek (1986). The Achievement Goal Theory assumes that *"…the individual is an intentional, goal-directed organism who operates in a rational manner, and that achievement goals govern achievement beliefs and guide subsequent decision making and behaviour in achievement contexts"* (Roberts, 2001b:10; Mallett & Hanrahan, 2004:186; Roberts *et al.,* 2007:4).

It is proposed that the overall intentions, motives and exertions of an individual are revealed through the goals this individual chooses, and that meaning can then assigned to their achievement orientated behaviour. Therefore, an individual's achievement orientated behaviour is determined by the (achievement) goals that they embrace. But, goals can take many forms, with the Achievement Goal Theory postulating that these goals mainly centre on the individual's desire to acquire or display competence and to minimise incompetence (Roberts *et al.,* 2007).

Murcia *et al.* (2007b:172) notes that according to the Achievement Goal Theory, *"…individuals can define success according to different criteria that reflects two different perspectives."* These perspectives are reflected in the majority of the studies concerned, with the most applicable incorporated into the explanations to follow. Also, while Roberts *et al.* (2007) is cited in the headings of these two perspectives, all the studies concerned incorporate these headings or variations thereof:

1) Task-involved (Roberts *et al.,* 2007:5)

This is also referred to as being self-referenced. This is an achievement goal perspective where individuals consider themselves to be successful when they have shown personal progress, competence or high levels of ability in a task. These task-orientated individuals demonstrate this personal competence, progression and ability through the successful completion or "mastering" of a task and are more likely to put in effort and to persist in a task in the face of challenges or setbacks (Duda & Hall, 2001; Mallett & Hanrahan, 2004; Vazou *et al.,* 2006; Wilson *et al.,* 2006; Cervelló *et al.,* 2007; Cumming *et al.,* 2007; Murcia *et al.,* 2007b; Roberts *et al.,* 2007).

Therefore, in more practical terms, these intrinsically motivated individuals participate in tasks for "the love of it" and for the inherent challenge associated with the task. Their motivation comes from the improvement shown in their superior performance of these skills after effort has been applied. In essence, they are focused on themselves and are involved in tasks for the betterment of themselves and the associated personal advantages of these improvements.

2) Ego-involved (Roberts *et al.,* 2007:5)

This is also referred to as being socially comparative. This achievement goal perspective is where individuals only regard themselves as successful if they exhibit superior skills when compared to others (Duda & Hall, 2001; Mallett & Hanrahan, 2004; Vazou *et al.,* 2006; Wilson *et al.,* 2006; Cervelló *et al.,* 2007; Cumming *et al.,* 2007; Murcia *et al.,* 2007b; Roberts *et al.,* 2007).

These individuals are only happy when they beat or vanquish others in these tasks, since this provides a perspective for them that they are better than others. It can probably be assumed that they care little for personal progression as sufficient reward and only experience reward in the context of superiority over others.

A number of points originally raised by Nicholls (1984; 1989) are highlighted by Roberts *et al.* (2007) regarding task versus ego-orientated individuals. Firstly, individuals who are task-orientated attempt to illustrate a level of mastery at a task rather than merely demonstrating an average level of skill in the task. They are not merely satisfied with being able to complete a task successfully; they desire excellence. In contrast, ego-orientated individuals only seek to demonstrate an average or normative ability or skill level in a task, as opposed to excellence or even perfection, since they are only concerned with ability to be superior over others, in spite of the quality of the performance. An important driver in this regard is that these individuals are seeking to avoid showing their inability in a task.

Another characteristic highlighted by Roberts *et al.* (2007) regarding ego-orientated individuals is that when these individuals consider themselves to be highly skilled or competent in a task, they generally seek out competitive environments in which to demonstrate this superior competence or ability in relation to others. They are usually motivated to persist in the task as a way of showing this superior competence. Further, they also like to be able to demonstrate competence in comparison to others with the minimum amount of application or work, and this minimal effort further serves to demonstrate their perceived superiority over others in the task. Conversely, however, these individuals avoid competitive or challenging environments if their perceived competence is low. Furthermore, their motivation to persist will is low and their consequent drop-out risk is high.

**5.2.1.1 Profile of Goal Orientation Questionnaire (PGOQ) (Wilson *et al.,* 2006:298)**

In subsequent reviews of and adaptations to the Achievement Goal Theory, Wilson *et al. (*2006:298) refer to the work of Harwood *et al. (*2002) that proposes *"…a four-goal model of achievement goals using the Profile of Goal Orientation Questionnaire (PGOQ)."*

In the model (PGOQ) of Harwood *et al.* (2002) in Wilson *et al.* (2006) the following applies:

1) Self directed task-involvement (Wilson *et al.,* 2006:298)

This is when an individual derives a sense of achievement or accomplishment when they experience an internal acknowledgement that their skill in a task has improved. An example of this is when an individual feels more competent because they can personally notice an improvement in their performance (Wilson *et al.,* 2006).

2) Social approval task involvement (Wilson *et al.,* 2006:298)

This entails the individual experiencing a sense of achievement or accomplishment when the recognition of their improvement in a skill or ability originates externally. An example of this is when an athlete demonstrates to their coach that they are improving in their skills (Wilson *et al.,* 2006).

3) Self-directed ego involvement (Wilson *et al.,* 2006:298)

This is when an individual has a sense of achievement or accomplishment based upon them recognising internally that they are better than others in a task. An example of this may be when an athlete experiences a feeling of competence and satisfaction when they exhibit superiority over other participants or competitors (Wilson *et al.,* 2006).

4) Social approval ego involvement (Wilson *et al.,* 2006:298)

This pertains to individuals feeling a sense of achievement or accomplishment when their superiority over others is recognised by an external source. An example of this is when an athlete has a sense of achievement in knowing that the coach realises that they're better than the opposition (Wilson *et al.,* 2006).

### 5.2.2 Self-Determination Theory

Vallerand (2007) explains that the Self Determination Theory expands upon the work of the early need theorists such as Deci and Ryan (1985; 2000). Central to this theory is the assumption that motivation is informed upon by the internal (intrinsic) needs of relatedness, self determination, autonomy and competence of the individual, and that these are essential for development and effective societal interaction (Chantal *et al.,* 1996; Deci & Ryan, 2000; Weinberg & Gould, 2003; Mallett & Hanrahan, 2004; Vallerand, 2007).

Furthermore, it is proposed that self determination and motivation can be classified along a continuum (Murcia *et al.,* 2007a, 2007b; Amorose & Anderson-Butcher, in press) consisting on the one end of individuals with no motivation (or amotivation), and on the other end of individuals who exhibit powerful intrinsic motivational characteristics.

Intrinsically motivated activities are those activities that individuals partake in for the personal satisfaction thereof or interest therein, as well as for the enjoyment and pleasure associated with the activity and the associated challenge and consequent opportunity to learn and to improve their competence (Chantal *et al.,* 1996; Vallerand & Rousseau, 2001; Mallett & Hanrahan, 2004; Amorose & Anderson-Butcher, in press).

Between the opposite poles of amotivation and intrinsic motivation lies extrinsic motivation (Amorose & Anderson-Butcher, in press). Extrinsic motivation involves the individual's participation in an activity as a means to an end, for external reward, not for the sake of participation alone (Chantal *et al.,* 1996; Vallerand & Rousseau, 2001; Vallerand, 2007; Amorose & Anderson-Butcher, in press) or through lack of choice (Mallett & Hanrahan, 2004).

Self determined behaviour is as Deci and Ryan (2000) describe it, the process whereby individuals attempt to internalise motives that are of an extrinsic nature. Therefore, it is a process of trying, as far as possible, to transform motivation from an external character to an internal character. According to this theory there are four categories of external or extrinsic motivation, some of which are more self-determined than others (Vallerand & Rousseau, 2001; Mallett & Hanrahan, 2004; Murcia *et al.,* 2007b; Vallerand, 2007; Amorose & Anderson-Butcher, in press) and these are situated on the continuum between amotivation and intrinsic motivation.

As a result, and judging from the explanations of the preceding studies, the Self Determination Theory suggest that the whole motivational continuum ranges from, a) amotivation through to, b) self determined extrinsic motivation moving from less internally controlled to more internally controlled motivation, and finally, c) pure intrinsic motivation.

The four categories of self determined extrinsic motivation are explained in the following section and are accompanied with short examples. While Murcia *et al.* (2007b) has been cited in the category heading section, these headings are found in all the studies concerned:

1) External regulation (Murcia *et al.,* 2007b:172)

This entails the participation in sport for external gain and persuasions with the behaviour regulated by external factors including those of constraints and benefits. This is the least self determined behaviour to be found (Deci & Ryan, 2000; Vallerand & Rousseau, 2001; Murcia *et al.,* 2007b; Vallerand, 2007; Amorose & Anderson-Butcher, in press). Examples of this include the participation in sport because of the associated prestige and possible financial rewards of success, or an individual going to practice so that the coach can see them and consider them favourably (Vallerand & Rousseau, 2001; Murcia *et al.,* 2007b; Vallerand, 2007)

2) Introjected regulation (Murcia *et al.,* 2007b:172)

This infers more internalised reasons for actions, although these are still affected by external factors, even though these factors may be self-imposed. This behaviour is still less self determined than the ideal (Deci & Ryan, 2000; Vallerand & Rousseau, 2001; Murcia *et al.,* 2007b; Vallerand, 2007; Amorose & Anderson-Butcher, in press). An example of this is participating in sport to assuage personal bad feelings, or attending practice because the associated guilt of missing practice would be too great to bear (Vallerand & Rousseau, 2001; Murcia *et al.,* 2007b; Vallerand, 2007).

3) Identified regulation (Murcia *et al.,* 2007b:172)

This refers to action that is completely out of choice and is therefore highly self determined. Individuals participate in these activities even if these activities are unpleasant (Deci & Ryan, 2000; Vallerand & Rousseau, 2001; Murcia *et al.,* 2007b; Vallerand, 2007; Amorose & Anderson-Butcher, in press). This may entail participating in sport for the express purposes of improving health or participating in weight training to improve performance, even if this weight training is not much liked or enjoyed (Vallerand & Rousseau, 2001; Murcia *et al.,* 2007b; Vallerand, 2007).

4) Integrated regulation (Murcia *et al.,* 2007b:172)

This involves doing an activity out of choice with this choice being to the benefit of other aspects of the individual (Deci & Ryan, 2000; Vallerand & Rousseau, 2001; Vallerand, 2007; Murcia *et al.,* 2007b). This can refer to participating in sport as part of one's broader attempt at a healthy and balanced lifestyle, or it may making sacrifices regarding one's social life to improve aspects of one's performance in competition (Vallerand & Rousseau, 2001; Vallerand, 2007; Murcia *et al.,* 2007b)

**5.2.2.1 Hierarchical Model of Intrinsic and Extrinsic Motivation (Vallerand, 2007:60)**

In an attempt to integrate the research findings on intrinsic and extrinsic motivation, the Hierarchical Model of Intrinsic and Extrinsic Motivation was first proposed by Vallerand (1997) in Vallerand (2007) and then subsequently by Vallerand (2001) and Vallerand and Rousseau (2001).

This model is best described by Vallerand (2007:60) as *"…five postulates and five corollaries. Taken together, these postulates and corollaries explain (a) the motivational determinants and consequences at three levels of generality as well as (b) the interactions among motivation at the three levels of generality, while taking into account the complexity of human motivation."*

This model has not been evaluated in-depth by this study, but it suffices to say that it extends the findings of intrinsic and extrinsic motivation by accounting for contextual, situational and personality factors as these interact with and influence each other and takes into account other considerations. The Self Determination Theory has significantly influenced this model and its development.

### 5.2.3 Sport Commitment Model

The Sport Commitment Model the Sport Commitment Model was developed in an attempt to understand the reasons and motivations of athletes to persist in and consistently participate in sport. (Carpenter *et al.,* 1993; Scanlan *et al.,* 1993a, 1993b; Carpenter & Coleman, 1998; Starkes 2000; Amorose, 2001; Brustad *et al.,* 2001; Wilson *et al.,* 2004; Tenenbaum & Hutchinson, 2007; Weiss & Weiss, 2007). The original authors (Carpenter *et al.,* 1993; Scanlan *et al.,* 1993a, 1993b) intended this model to be applied to both adult and youth sport at a recreational and elite level.

There are some (Brustad *et al.,* 2001; Tenenbaum & Hutchinson, 2007) who point to the preceding work of Scanlan and Simons (1992) as contributing to the development of this model. And, this model has even been referred to by Spamer and Winsley (2003b) in their study on talent identification with eighteen year old English and South African rugby players. .

Scanlan *et al.* (1993a:3) highlight three important factors pertaining to commitment. These include the definition of commitment, which they define as, a *"…general psychological state."* Furthermore, they stress the fact that their model needs to be distinguished from the "causal" as well as the consequences of commitment, and note that they are specifically concerned with the *"…state of commitment and its antecedents or determinants."* They do go on to say that their model does consider the *"…behavioural consequences"* of commitment. And finally, Scanlan and colleagues (1993a:4) view commitment as reflecting *"…either wanting to or having to continue, or some combination of the two."*

According to this model, commitment to sport is a function of several independent factors or constructs that either have an augmenting influence on sport commitment and participation, as their respective ratings increase. These are named and described in short hereafter. Scanlan *et al.* (1993a) has been cited as the source of the headings, but, these headings appear in all the studies concerned:

1) Sport enjoyment (Scanlan *et al.,* 1993a:6)

This refers to how much the child enjoys participating in the sport and refers to the amount of pleasure, liking and fun the child derives from their involvement (Carpenter *et al.,* 1993; Scanlan *et al.,* 1993a, 1993b; Brustad *et al.,* 2001; Wilson *et al.,* 2004; Weiss & Weiss, 2007).

2) Involvement alternatives (Scanlan *et al.,* 1993a:7)

This entails the attractiveness of other alternatives or involvement opportunities that would compete with the child's current involvement and could likely influence their persistence in their current endeavour (Carpenter *et al.,* 1993; Scanlan *et al.,* 1993a, 1993b; Brustad *et al.,* 2001; Wilson *et al.,* 2004; Weiss & Weiss, 2007).

3) Personal investment (Scanlan *et al.,* 1993a:7)

This is defined as the investment of personal resources such as effort, money and time into the activity. The nature of this investment is that it is irretrievable if the child ceases participation in this activity (Carpenter *et al.,* 1993; Scanlan *et al.,* 1993a, 1993b; Brustad *et al.,* 2001; Wilson *et al.,* 2004; Weiss & Weiss, 2007).

4) Social constraints (Scanlan *et al.,* 1993a:7)

This refers the expectations of others that weigh on the child's decision to participate and persist in an activity (Carpenter *et al.,* 1993; Scanlan *et al.,* 1993a, 1993b; Brustad *et al.,* 2001; Wilson *et al.,* 2004; Weiss & Weiss, 2007).

5) Involvement opportunities (Scanlan *et al.,* 1993a:8)

This has to do with highly regarded opportunities that may present themselves should the child persist in the activity and include the "perfection" of the task or social interaction or even the achievement of higher honours in the sport or task (Carpenter *et al.,* 1993; Scanlan *et al.,* 1993a, 1993b; Brustad *et al.,* 2001; Wilson *et al.,* 2004; Weiss & Weiss, 2007).

The respective augmenting and diminishing influence of each of these constructs can be identified. The influence of increased or augmented enjoyment, personal investment, social constraints and involvement opportunities has a positive impact on commitment to a sport or activity. Conversely, the influence of increased involvement opportunities has the potential to diminish or decrease commitment to a sport or an activity (Carpenter *et al.,* 1993; Scanlan *et al.,* 1993a, 1993b; Brustad *et al.,* 2001; Wilson *et al.,* 2004; Weiss & Weiss, 2007).

Scanlan and colleagues (1993a) implied that children are usually involved in multiple activities and that this negated the potentially negative impact of increased involvement opportunities. Furthermore, they found the two most important of these constructs were personal investment and sport enjoyment with these accounting for 58% of the variance in sport commitment.

An important note at this juncture is that the original authors of this model (Scanlan *et al.,* 1993a:2) stated that they expected the model to *"…undergo change. With further testing, we will better understand which model components work in diverse sport contexts, and what modifications and additions to the model and its measures are required"* and this has in fact happened.

In citing the findings of the investigations of Carpenter and Coleman (1998) and Carpenter and Scanlan (1998) on the Sport Commitment Model, Wilson *et al. (*2004) highlights that social constraints were found to be unassociated or even to have negative correlations with commitment. Furthermore, the findings of Carpenter and Coleman (1998) in their study of elite cricketers were that social support as a construct has a positive association with sport commitment, with the opposite also true.

### 5.2.4 Deliberate Practice

The Deliberate Practice Theory of Ericsson *et al. (*1993) was included in the preceding chapter (four) of this study due to its highly nurturist viewpoint and due to the subsequent proposals of its first author and main proponent in this study and others (Ericsson & Lehmann, 1996; Ericsson, 2003a, 2003b, 2007a, 2007b; Ericsson *et al.,* 2005, 2007a, 2007b) that all limitations can be overcome by proper, deliberate and focussed practice. These arguments also reject the genetic contribution to excellence in sport. Their argument therefore stands (and is extended) that excellence and expertise is achieved almost solely as a result of this deliberate and focused practice.

It is not within the scope of this section to evaluate this theory's main tenets (for an in-depth review, see chapter four) but, the focus will rather rest on one of the original proposals that high levels of motivation and commitment (psychological constructs) are needed to persist in this process of deliberate practice are also considered, as well as the fact that in contrast to the Sport Commitment Model, it is postulated that deliberate practice is not enjoyable.

The Theory of Deliberate Practice of Ericsson *et al.* (1993) has as its central thesis that those who exhibit expertise or excellence in a domain consistently engage in deliberate and specific practice activities and efforts that are well defined and structured, with this practice serving the purpose of improving specific important aspects of performance through continuous repetition and subsequent improvement (Ericsson *et al.,* 1993; Ericsson & Lehmann, 1996; Durand-Bush & Salmela, 2001; Johnson *et al.,* 2006; Ericsson, 2004, 2007a). In so doing, these individuals continually and consistently improve those aspects that are critical to excellence and superior performance in the task.

Important constraints inherent to this theory were identified by Ericsson *et al. (*1993) and two of the most pertinent are earmarked for this evaluation:

One of the original constraints was that a high degree of effort is required, since deliberate practice entails significant physical and mental demands (Ericsson *et al.,* 1993; Starkes *et al.,* 2001; Durand-Bush & Salmela, 2001; Baker *et al.,* 2003a, 2003b, 2005; Janelle & Hillman, 2003; Summers, 2004; Ward *et al.,* 2004; Hyllegard & Yamamoto, 2005; Côté *et al.,* 2007; MacMahon *et al.,* 2007).

Another constraint is that deliberate practice is not an enjoyable activity and therefore requires strong motivation to persist in this process. (Ericsson *et al.,* 1993; Starkes *et al.,* 2001; Durand-Bush & Salmela, 2001; Baker *et al.,* 2003a, 2003b, 2005; Janelle & Hillman, 2003; Summers, 2004; Ward *et al.,* 2004; Baker *et al.,* 2005; Hyllegard & Yamamoto, 2005; Côté *et al.,* 2007; MacMahon *et al.,* 2007).

As the original authors (Ericsson *et al.,* 1993) rightly state, sufficient mental (and physical) resources would certainly be required to persist in the kind of training and practice that they propose. As is shown later in this chapter, the proper type of motivation (it is proposed by this study that this requisite motivation is characterised by a task orientated goal perspective rather than the converse ego orientation; it also needs to be heavily biased in favour of an intrinsic motivational approach) is critical to persist in this kind of training.

And, since Ward *et al.* (2004:232), when referring to the original work of Ericsson *et al.* (1993), observe that the *"…motivation to sustain participation is largely determined by one's intent to improve. Without the goal of improving performance, the motivation to engage in such practice is likely to diminish,"* the task centered, intrinsic motivation sentiments forwarded in the previous paragraph make perfect sense.

Persistent, specific and deliberate practice that is advantageous to the development and constant improvement of all the physical and skill related aspects that are required for superior performance in sport is of the utmost importance (Baker & Davids, 2007b). To persist in this kind of practice requires total commitment, dedication and motivation.

## 5.3 PERCEPTUAL-COGNITIVE AND PERCEPTUAL-MOTOR SKILLS

### 5.3.1 Perceptual-cognitive abilities and skills

From a brief cross-sectional representation of the literature, the views are unanimous that cognitive and related perceptual abilities are overwhelmingly influential in motor performance and the associated attainment and achievement of excellence and expert performance in elite sport (Williams *et al.,* 1994; Tenenbaum *et al.,* 1996; Helsen & Starkes, 1999; Tenenbaum *et al.,* 1999; Singer, 2000; Williams, 2000, 2002; Starkes *et al.,* 2001; Baker *et al.,* 2003a, 2003b; Ericsson, 2003a; Ward & Williams, 2003; Williams & Ward, 2003; Williams *et al.,* 2003, 2004; Elferink-Gemser *et al.,* 2004; Williams & Ericsson, 2005; Hodges *et al.,* 2006; Vaeyens *et al.,* 2007; Williams & Ward, 2007; Pesce *et al.,* in press).

#### 5.3.1.1 Background

Research into expertise and expert performance has a history spanning more than 100 years in psychology (Ackerman & Beier, 2003), with a number of the more recent research paradigms and approaches regarding the study of perceptual-cognitive expertise and abilities increasing in popularity from the 1970's and onwards (Hodges *et al.,* 2006).

It is however the important work of de Groot (1978), originally performed on chess masters and lesser players and first completed in 1946, that is considered the mainspring of all expertise study (Ericsson, 1996a; Williams & Ericsson, 2005; Ericsson, 2006a). Ericsson (2006a) feels that it was upon the translation of de Groot's (1946) study into English at the end of the 1960's that the full impact of his work was felt, with this providing impetus to the work of Simon and Chase (1973) and their so-called "seminal theory of expertise."

It was noted earlier that while sport psychology is certainly not a new science (Weinberg & Gould, 2003), it has experienced a relatively recent rise in prominence, with the start of this rise dating back to the 1960's and 1970's (Singer *et al.,* 2001; Weinberg & Gould, 2003; Wuest & Bucher, 2006).

Central to the cognitive and perceptual-cognitive perspectives is the information processing theory and the associated theorisations around this theory, as well as its application to excellence and expertise in sport from a psychological perspective. Therefore, before the information processing theory is reviewed, a brief discussion regarding its evolution and development is in order. The main thrust and drive in the development of the information processing approach is what is commonly termed the "cognitive revolution", discussed hereafter.

##### *5.3.1.1.1 Cognitive Revolution*

Concurrent with and contributing to the development and evolution of sport psychology as a self standing discipline in the second half of the previous century, there arose a psychological school of thought based on a cognitive perspective.

This came about as a result of changes in the approach to psychology at the time, with these changes at various times being referred to as *"The cognitive trend"* (Jordaan & Jordaan, 1984:31), *"…'cognitive revolution'"* (Summers, 2004:6), *"The rise of cognitivism"* (Amirault & Branson, 2006:78) and others. The term chosen for this study is the cognitive revolution.

The origin of cognitive psychology can be traced back to this cognitive revolution, starting in the 1960's in response to the perceived limitations of behaviourism (Jordaan & Jordaan, 1984, 1998; Summers, 2004; Anderson, 2005; Amirault & Branson, 2006) and gave rise to the information-processing approach. The information-processing approach has impacted upon research into psychology since its inception (Singer, 2000; Summers, 2004; Feltovich *et al.,* 2006) and is discussed in more detail later in this chapter.

Three main sources are commonly identified by researchers (to varying degrees) as contributing toward the cognitive revolution and the resultant development of the information-processing approach:

1) The decline of the influence of behaviourism.
2) The impact of linguistics.
3) The rise of artificial intelligence.

These will be briefly reviewed hereafter:

1) Behaviourism is an approach to psychology that adopts the view that only observable behaviour in humans can be studied, since thought processes and consciousness cannot be measured in an objective manner. The father of this approach is John B. Watson and the first decade of the 1900's is regarded as the period in which this approach has its origin (Jordaan & Jordaan, 1984, 1998; Reber, 1985; Anderson, 2005; Feltovich *et al.,* 2006).

This approach was felt to be too limiting and unable to explain certain psychological aspects (Cummins & Cummins, 2000). Due to the impractical nature of this to adequately explain general mental capacities and advanced mental faculties such as creativity in language and the ability to reason in a logical manner, it lost its hold on psychology (Jordaan & Jordaan, 1984, 1998; Summers, 2004; Anderson, 2005).

2) Linguistics is *"…the study of the origins, evolution and structure of language(s)"* (Reber, 1985: 405). Linguistics was found to adequately address some of the afore-mentioned complex human processes and in so doing helped to counteract the influence of behaviourism (Anderson, 2005; Feltovich *et al.,* 2006). The influential contributions of Noam Chomsky in the late 1950's and 1960's are regarded highly in the field of linguistics (Reber, 1985; Anderson, 2005; Feltovich *et al.,* 2006).

3) Steedman (1998:173) defines the relationship between cognitive science and artificial intelligence as follows: *"Cognitive science is a field that builds on knowledge from many disciplines. Important contributions have come from computer science, especially from artificial intelligence."* Buchanan *et al. (*2006) refer to one prominent branch of artificial intelligence as seeking to understand and "faithfully simulate" the approaches and methods of humans in solving problems, and they call this the psychological branch of artificial intelligence.

Historically, the field of artificial intelligence started midway through the 1950's (Buchanan *et al.,* 2006). Since then it has developed and become focused on more complicated tasks and environments characterised as being rich in knowledge. As a result of this increased focus on what is termed strong, "knowledge based" methods of research, a totally new expert systems industry was born (Feltovich *et al.,* 2006). It is said that the principles of artificial intelligence form the backbone of these expert systems, with Buchanan *et al. (*2006:87) describing expert systems as *"…computer programs that exhibit some of the characteristics of expertise in human problem solving, most notably high levels of performance."*

*5.3.1.1.2 Information-processing approach*

As established earlier, the result of the cognitive revolution was the information-processing theory/approach. The information-processing approach/model provides an explanation for the performance of humans in motor tasks.

The information participants receive from their immediate environment proceeds through various stages to arrive at a decision and an associated outcome. The general stages commonly identified by most studies are, 1) identifying a stimulus through perception; 2) deciding on or selecting an appropriate response, and; 3) executing the appropriate response (Allard, 1993; Wrisberg, 1993, 2001; Coker, 2004; Summers, 2004; Anderson, 2005; Hodges *et al.,* 2006; Wuest & Bucher, 2006). Coker (2004) and Wuest and Bucher (2006) add another stage to this process, namely that of feedback of outcomes and results, with this feedback assisting the individual in modifying their performance.

Often the explanation for this cognitive behaviour uses the computer (Singer, 2000; Summers, 2004). An important aspect of this approach is the total time taken to react or to respond (called reaction-time) to the stimulus, with this providing an idea of the processing speed and ability of the individual (Wrisberg, 1993, 2001; Hodges *et al.,* 2006). It is the information processing approach of cognitive psychology that has been the major thrust of psychological research into excellence and expert performance in general (Summers, 2004) and in sport (Hodges *et al.,* 2006) since its inception.

Decision making and anticipation are regarded as prominent perceptual-cognitive abilities or skills, with decision making also referred to as response selection. The number of studies (Tenenbaum *et al.,* 1996; McMorris, 1999; Lyoka & Bressan, 2003; Zoudji & Thon, 2003; Bock-Jonathan *et al.,* 2007; Vaeyens *et al.,* 2007) and texts (Tenenbaum, 2003; Hodges *et al.,* 2006, 2007; Williams & Ward, 2007) focusing on or stressing the importance of decision making, anticipation and the different aspects associated with these abilities, serve to confirm the importance of this ability in sport.

An important part of effective decision making is perception and vision. Skill in perception is imperative to superior ability in sport (Williams, 2000, 2002; Starkes *et al.,* 2001; Ward & Williams, 2003; Vaeyens *et al.,* 2007; Pesce *et al.,* in press). And, while visual system itself is regarded as being critical to aiding skilled perception (Ward & Williams 2007) and the search for relevant information needed to perform at optimal levels (Williams, 2002), there is little concrete proof that those who excel at sport do so because of an advantage in their visual systems or abilities as such (Ward & Williams, 2003; Vaeyens *et al.,* 2007; Williams & Ward, 2007).

This distinction between the visual system and associated perception is significant. Williams (2000), Starkes *et al. (*2001) (and others) distinguish between those components of vision that are fixed and cannot be changed (traditionally called “hardware”) such as depth perception and peripheral vision and those components that can be changed, learned and practiced (traditionally called “software”) such as recall and recognition, visual search strategies, game information, sport specific knowledge and even eye movement responses.

There is little evidence that skilled sports participants have enhanced or superior visual systems (Baker, 2003; Ward & Williams, 2003; Baker & Horton, 2004; Williams & Ward, 2007). Cooper and Goodenough (2007) do however refer to the work of Dr. Sherylle Calder in successfully developing and improving not only visual reaction time and memory, but also variable depth and peripheral vision, amongst others. Meir (2005) in turn ascribes to visual fitness in sports. In citing Calder (1995) and Wilson and Falkel (2004), Meir (2005) goes on to say that by training the visual fitness of players, aspects such as peripheral vision, visual-perceptive skills, focusing skills and eye-movement skills can be enhanced. There are also further suggestions that studies be done examining how visual function improves with age and maturation (Williams & Ward, 2007).

Of particular interest to researchers is that of what is perceived by the individuals from the sporting environment and how this perceived information is detected and optimally utilised. It has been said earlier in this chapter, but, experts are superior in many of the perceptual-cognitive aspects of performance (Starkes *et al.* 2001; Williams *et al.,* 2004; Hodges *et al.,* 2007; Williams & Ward, 2007) and it is these aspects that are of interest to the following sub-section of this study.

#### 5.3.1.2 Leading research findings

In this sub-section, the leading and enduring research findings regarding the perceptual-cognitive advantages that expert athletes possess in greater abundance than non-expert athletes are presented. These findings have been confirmed in research time and again and consequently, scores of research and associated findings exist on most of the issues. While the headings of each point in this sub-section will be attributed to a specific study, this by no means implies that it is merely that specific study that has raised these findings, as the accompanying references to each point attest to.

With this in mind, the following prominent findings apply:

*5.3.1.2.1 Information recall, retention and recognition (Helsen & Starkes, 1999)*

Superior performers have better information or pattern recall, retention and recognition abilities in environments that are structured or conform to a known pattern, than do less successful performers (Williams *et al.,* 1994, 2003, 2004; Helsen & Starkes, 1999; Tenenbaum *et al.,* 1999; Williams, 2000; Starkes *et al.,* 2001; Baker *et al.,* 2003b; Lyoka & Bressan, 2003; Ward & Williams, 2003; Williams & Ward, 2003, 2007; Abernethy *et al.,* 2005; Hodges *et al.,* 2006; Vaeyens *et al.,* 2007). This translates into a distinct advantage on the field when making decisions and selecting responses to the unfolding game environment (Lyoka & Bressan, 2003; Hodges *et al.,* 2006).

The essential premise of this advantage in recall, retention and recognition of information that experts possess over others is their ability to organise the information they perceive in their specific environment into larger units for storage in memory and for subsequent recall and utilisation in game scenarios (Williams, 2000; Lyoka & Bressan, 2003). It can be assumed from these explanations that as an individual gains experience in a domain (this can include sport) through active involvement by means of practice and competition, they become more effective with this memory recall, retention and recognition.

It is the original research of Chase and Simon (1973a; 1973b) and de Groot (1978), all on chess that first gave impetus to these findings. The process of organising and storing information mentioned in the paragraph above is called "chunking," and it was Chase and Simon (1973a; 1973b) who proposed this theory (Williams, 2000; Baker, 2001; Lyoka & Bressan, 2003; Tenenbaum, 2003; Ericsson, 2006a; Gobet, 2005; Williams & Ericsson, 2005; Feltovich *et al.,* 2006; Hodges *et al.,* 2007). There are others (Baker, 2003; Baker *et al.,* 2003c; Ericsson, 2003a, 2004, 2005, 2006a; Feltovich *et al.,* 2006; Williams & Ward, 2007) who also attribute the theory of chunking or certain aspects thereof to the specific study of Simon and Chase (1973) as well.

But, the significance of de Groot's (1978) work can also be appreciated. Originally, de Groot's (1978) ground breaking study was completed in 1946 and was done on the differences in performance between the world's top chess players as compared to less skilled club players, with his study is widely acknowledged by many as being of great value to the field of expertise. Others (that are also included in these references) go further in stating that de Groot's (1978) study can be seen as being contributory to the development of the first expertise theory (Ericsson & Lehmann, 1996; Ericsson, 2003a, 2004, 2005, 2006a, 2007a; Williams & Ericsson, 2005; Gobet & Charness, 2006).

The specific findings of de Groot's (1978) research were that the superior performers could be distinguished with regards to their memory, in that they could recall briefly presented chess positions far better than the lesser skilled performers (Gobet & Charness, 2006). Further findings were that their advantage lay in their reliance on planning and patterns that they acquired over time (Ericsson, 2006a) and that they had a superior ability to select the next best move (Ericsson, 2005, 2007a; Vaeyens *et al.,* 2007). De Groot's (1978) study is highly regarded and is seen as having great impact upon the studies of expertise studies that followed, the most significant of which being the study of Simon and Chase in 1973 (Ericsson, 2006a).

The prominence of Simon and Chase (1973) lies in the fact that they elaborated on de Groot's (1978) original work by proposing the first major expertise theory (Ericsson, 2003a, 2005, 2006a; Williams & Ericsson, 2005). The specific and enduring contributions of Simon and Chase (1973) are the fact that they observed that nobody attained the level of international chess master (grandmaster) with less than a decade's worth of intense preparation, with this finding also applicable to other domains (Ericsson & Lehmann, 1996; Baker *et al.,* 2003a, 2003b, 2003c; Baker & Horton, 2004; Ericsson, 2004, Ward *et al.,* 2004; Charness *et al.,* 2005). And, as noted earlier, the chunking theory (or aspects thereof) is also attributed to their study by researchers (Baker, 2003; Baker *et al.,* 2003c; Ericsson, 2003a, 2004, 2005, 2006a; Feltovich *et al.,* 2006; Williams & Ward, 2007).

As a summary of this concept, in applying chunking to a sporting context, it can be said that chunking is the organisation of information into patterns and configurations of memory. It is in the decoding and encoding processes whereby the relevant information configurations are recognised and either retrieved or stored (Allard, 1982 in Lyoka & Bressan, 2003). This more highly developed ability to encode, decode and chunk the applicable aspects of the game results in the improved ability of top performers to display more efficient decision making skills. Experts and superior performers have been shown to be superior in the perception of the information emanating from the game environment, to be faster with memory processing abilities, to be able to efficiently access and recall the applicable information structures, with this enabling them to be more effective decision makers (Garland & Barry, 1990 in Lyoka & Bressan, 2003).

The theories Simon and Chase (1973) and Chase and Simon (1973a; 1973b) have been questioned, and in certain cases disproved (Ericsson, 2003a; Ericsson, 2005; Williams & Ericsson 2005). This doesn't detract from the legacy that they and de Groot (1978) left in the field of psychological enquiry into expertise and expert performance (with this also extending to sport) however. The preceding discussion is more than enough evidence of the fact that they are still held in high regard.

*5.3.1.2.2 Sport-specific knowledge (Bock-Jonathan et al., 2007)*

Superior performers possess greater amounts of task (Williams & Davids, 1998) and domain-specific knowledge, and this is true of sport as well (Helsen & Starkes, 1999; Bock-Jonathan *et al.,* 2007). Domain and sport-specific knowledge is contained in the amount of procedural, declarative and strategic knowledge the participant possesses (French & McPherson, 1999; Helsen & Starkes, 1999; Kluka, 1999; Starkes *et al.,* 2001; Thomas *et al.,* 2001; Janelle & Hillman, 2003; Hodges *et al.,* 2006). Declarative knowledge implies an overall knowing and understanding of the sport, such as the rules, positions and others (Kluka, 1999; Thomas *et al.,* 2001; Janelle & Hillman, 2003; Lyoka & Bressan, 2003; Elferink-Gemser *et al.,* 2004; Hodges & Franks, 2004; Hodges *et al.,* 2007). Procedural knowledge entails understanding how to play the sport (Kluka, 1999; Thomas *et al.,* 2001; Janelle & Hillman, 2003; Lyoka & Bressan, 2003; Elferink-Gemser *et al.,* 2004; Hodges *et al.,* 2006, 2007). Finally, strategic knowledge is knowledge of how to most effectively or proficiently perform the task or to play the game under the prevailing circumstances (Kluka, 1999; Janelle & Hillman, 2003).

Lyoka and Bressan (2003), in citing Papanikolau (2000), refer to the term athletic intelligence as relating to the types of knowledge needed to be successful in sport. In expanding on this concept, a review of Gould's *et al. (*2002) findings on this topic is quite relevant. The authors commented that this aspect of sport intelligence (along with mental toughness-see later in this chapter) was to them a new variable that was identified is being quite valuable. Under this concept were listed aspects such as having a firm grasp of the elite nature of sport, good decision making, being analytical, innovative and able to learn quickly and being a student of the sport.

When compared to Lyoka and Bressan's (2003) views that sport intelligence entails being able to effectively perform the proper and most relevant skills in a specific context, then this concept of sport intelligence as an extension of domain and sport-specific knowledge becomes a fruitful and ripe topic for future enquiry. Further investigation into this aspect is also a recommendation of Gould and colleagues (2002).

*5.3.1.2.3 Faster and more efficient processing of information (Starkes et al., 2001*

Superior performers deal with and process the information they receive from the environment more quickly and effectively than others (Helsen & Starkes, 1999; Starkes *et al.,* 2001; Williams *et al.,* 2004; Bock-Jonathan *et al.,* 2007). This ability is a critical determinant of decision making and anticipation and is related to factors such as pattern recognition (discussed before), effective utilisation of advanced cues, the ability to determine situational probabilities and effective visual search behaviours (Williams & Ward, 2007). Each of these factors will be briefly discussed hereafter:

*5.3.1.2.3a Situational probabilities (Williams et al., 2004:332)*

The concept of situational probabilities refers to when superior performers have the ability to establish or predict where a current situation will lead or end up (Baker, 2001; Starkes *et al.,* 2001; Williams & Ward, 2003, 2007; Williams *et al.,* 2004; Vaeyens *et al.,* 2007).

*5.3.1.2.3b Visual search behaviour (Williams et al., 2004:330)*

Superior performers have more effective visual search behaviours and strategies in relation to others (Williams & Davids, 1998; Helsen & Starkes, 1999; Starkes *et al.,* 2001; Williams, 2002; Ward & Williams, 2003; Williams & Ward, 2003, 2007; Williams *et al.,* 2004; Hodges *et al.,* 2006, 2007; Vaeyens *et al.,* 2007). There have been interesting findings in this field, particularly with regards to the fixations that players employ in sport and the differences between experts and non-experts. It has been found that experts generally employ less eye fixations than non-experts, but that this is also highly specific to the sport involved, where studies have also shown more eye fixations and altered search strategies in experts in different situations (Hodges *et al.,* 2006, 2007). Furthermore, Vaeyens *et al.* (2007) found that different circumstances also called for different visual search strategies involving the rate of search, the number of eye fixations and the length of these eye fixations.

*5.3.1.2.3c Advanced cue utilisation (Williams & Ward, 2007:205)*

It has been shown by extensive studies that superior performers have an advantage in their ability to make use of advanced cues (Abernethy & Russell, 1987; Williams *et al.,* 1994, 2003, 2004; Helsen & Starkes, 1999; Starkes *et al.,* 2001; Lyoka & Bressan, 2003; Ward & Williams, 2003; Williams & Ward, 2003, 2007; Abernethy *et al.,* 2005; Hodges *et al.,* 2006; Vaeyens *et al.,* 2007).

This utilisation of advanced cues is when superior performers can anticipate and predict immediate or imminent future events based on the information emanating from opponents. This advanced cue utilisation occurs when information is derived from body or postural cues presented by opponents in the way they move and even before they make contact with a racquet, volleyball or a football. In this way experts often accurately interpret the direction of the opponent, ball or object and can make the adjustments needed to successfully attend to the required task or response (Abernethy & Russell, 1987; Starkes *et al.,* 2001; Williams *et al.,* 2004; Hodges *et al.,* 2006; Williams & Ward, 2007).

*5.3.1.2.4 Trainability and transferability of perceptual-cognitive abilities*

As a final consideration of this sub-section, the prospects of training and transferring these perceptual and cognitive abilities and skills is discussed, with these issues raised by a number of authors and studies (Starkes *et al.,* 2001; Williams & Ward, 2003; Williams *et al.,* 2003, 2004; Hodges *et al.,* 2006; Vaeyens *et al.,* 2007; Williams & Ward, 2007). It seems that while the proverbial "jury" is still out on the issues of both the trainability and transferability of (certain) perceptual-cognitive abilities, there are some findings to date worth mentioning.

1) The development of the expert advantage in information recall, retention, recognition due to extended practice and exposure to (training in) a sport, as well as the associated and implied requirements for training and exposure when developing task and sport-specific knowledge, has been well documented earlier in this chapter. In fact, without *dedicated practice*, there will be *no development* of *or improvement* in these skills. In going further, Williams and Ward (2007) are of the opinion that the results obtained from studies aimed at training other perceptual-cognitive aspects and skills using simulation and instruction can be said to be encouraging. They and Williams *et al.* (2004) do however cast a light on the methodological shortcomings and the lack of literature that sustain these findings.

According to Williams and Ward (2003), Williams *et al.* (2004) and Jordet (2005), the majority of research into the trainability of anticipation skills has focused on and attempted to train the individual to improve their ability in utilising advanced cues to improve their performance. But, in spite of the research limitations encountered in many studies of this type, in other well designed studies some impressive results were obtained. In the work of Williams *et al.* (2003) aimed at improving the anticipation skills of field hockey players through developing their ability to read advanced cues, a (perceptual) training effect was found (Williams & Ward, 2003; Williams *et al.,* 2003, 2004). The issue of pattern recognition has received little attention, with situational probabilities receiving none to date (Williams & Ward, 2003; Williams *et al.,* 2004). In a study by Vaeyens *et al.* (2007), a suggestion was made for the task-specificity in practice when attempting to improve visual search strategies, indicating another possible avenue of perceptual-cognitive training.

2) The question of the transferability of perceptual-cognitive expertise and ability is truly an intriguing one. Ericsson and Lehmann (1996) and Feltovich *et al.* (2006) are of the opinion that expertise is not a general ability that can be transferred to many domains and that you don't find people who are experts in more than one field or domain. Furthermore, task specificity relating to expertise in surgery is mentioned by Norman *et al. (*2006), who say that the ability inherent to one surgical task does not transfer to another surgical task. Lehmann and Gruber (2006) for their part say that in music, the improvement that comes about in musicians as a result of practice is limited to the specific instrument they are practicing on. It seems that is quite simply very rare or nigh on the impossible to be an expert in the strictest sense of the word, in more than one domain.

Or is it? MacMahon *et al. (*2007:65) phrase their sentiment nicely and succinctly by asking *"How domain-specific are domain-specific skills?"*

It is common knowledge that skill transference occurs in motor skill acquisition and development (Magill, 1998; Wuest & Bucher, 2006). Furthermore, du Toit *et al.* (2006a:47) found that *"…a transfer effect of eye-hand co-ordination skills from the right to the left cerebral hemispheres does exist"* after practicing unilaterally to develop the co-ordination skills of the left hand. Grassi *et al.* (2006) also found skill transfer in hand-eye coordination. But, while these examples certainly support motor-skill transfer under certain basic and limited conditions, is there a specific, perceptual-cognitive transfer to be found at high levels of sport participation?

Evidence for this transfer is beginning to emerge. Hodges *et al.* (2006:478) say that some of the information and findings from certain studies *"…suggests that some transfer of perceptual skill is seen across sports with similar skill demands."*

Others, such as MacMahon *et al.* (2007) make mention of yet other studies, such as those of Smeeton *et al.* (2004) and Abernethy *et al.* (2005) that investigated the transferability of perceptual-cognitive skill. Upon closer analysis of these specific studies, the following can be seen: Abernethy *et al. (*2005) found that the elite performers of various sports did show limited amount of transfer of pattern recall from sports that were not their own, with the study of Smeeton *et al. (*2004) generating similar results. In the study of Smeeton *et al. (*2004), the highly skilled field hockey and soccer players were found to be able to identify action sequences from both sports. The highly skilled volleyball players were found to be the worst at recognising action sequences of both soccer and hockey, with no differences found between recognition ability of the soccer, volleyball and hockey players when required to recall volleyball action sequences. The findings of these studies therefore show that there is transfer of perceptual-cognitive skills between similar sports types, a view that Abbott *et al.* (2007) also hold to.

MacMahon *et al.* (2007), however mention that while there may be transfer between perceptual-cognitive skills that are similar in nature, there is no transfer of perceptual-cognitive skills between *differing roles.* MacMahon *et al.* (2007) strengthen their argument by citing the studies of Allard *et al. (*1993) and Williams and Davids (1995) that provide examples of role specific perceptual-cognitive expertise and ability.

Since the evidence provided seems arrive upon a stalemate, a search of real life cases suffices. A number of examples were found. Fein (2007) noted that Scott Draper, a former professional tennis player, had successfully made the transition to professional golf by winning the New South Wales PGA Championship in February of 2007. Former All Back rugby player Jeff Wilson also successfully transitioned from rugby to become a Black Cap national cricket player (Unknown Author, 2007b). Closer to home Conrad Jantjes achieved junior South African colours in rugby as well as soccer and cricket (Unknown Author, 2005). South African cricket player and opening batsman Herschelle Gibbs played soccer for the South African Schools

Under-16 team (Unknown Author, 2007c). And, former South African cricket player Jonty Rhodes also represented South Africa at hockey and was picked to go to the Barcelona Olympic Games in 1992; unfortunately the squad did not qualify for the tournament (Unknown Author, 2007d). Abbott *et al.* (2007) also provide evidence of sportspersons who transfer from one sport to another, and they are of the opinion that this ability to transfer from one sport to the next is as a result of early diversification in sport and a focus on many sports as opposed to an early one sport focus.

Therefore, while it is almost a given that perceptual, cognitive and motor skill transfer assisted in these transitions between and excellence in multiple sports endeavours, it has been noted throughout this study that performance does not just consist of these aspects, but of certain physical and physiological parameters too. Therefore, a solution would perhaps be to study the specific perceptual-cognitive skills as well as other physiological aspects and abilities of such individuals who are successful in multiple sports.

### 5.3.2 Perceptual-motor abilities and skills

The literature also highlights the recent rise of alternative approaches to researching expertise and expert performance. The specific perspectives and views within literature and as contained in some of this literature cited in preceding sections, as well as other literature, have been included in this section.

Just as the cognitive school of thought arose out of the perceived limitations of behaviourism in explaining complex behaviours, so too another change in perspective is occurring due to the perceived short-comings of the cognitive approach in explaining skilled behaviour and excellence (Summers, 2004). These alternative theories and explanations to the traditionally cognitive explanations of expert performance that have arisen of late are those of the ecological and dynamical systems theories (Davids *et al.,* 2001, 2007; Starkes, 2003; Summers, 2004; Hodges *et al.,* 2006; Williams & Ward, 2007), with both Kluka (1999) and

Summers (2004) of the opinion that the dynamical systems approach arose from ecological psychology.

While these two theories and approaches have some differences, they do have certain similarities. The most prominent similarity between these approaches is that they both largely refute the traditional view that is reliant on cognition and cognitive factors to facilitate skilled movement and excellence (Kluka, 1999; Beek *et al.,* 2003; Coker, 2004; Summers, 2004; Rosenbaum *et al.,* 2006; Williams & Ward, 2007). Cognitive factors are relegated by these approaches to the role of *"…setting up self-assembly (i.e. leading to the emergence of self-organized behaviour), not explicitly controlling such processes during movement coordination"* (Davids *et al.,* 2001:144; Araújo *et al.,* 2004:418).

Another similarity that has been identified by Beek *et al.* (2003) is that both these approaches emphasise factors that are reliant on or determined by a number of elements and that these factors and elements in turn influence perception and action. To further illustrate this, Davids *et al. (*2007:227), in referring to Bernstein (1967), explain that *"Researchers in these areas have typically adopted a systems perspective. They have sought to characterize biological movement systems as complex, dynamical systems, revealing how the abundance of degrees of freedom is coordinated and controlled during goal-directed movements."* Therefore, according to Davids *et al.* (2007), these approaches are relevant to sport psychology because, being described as "constraints-based frameworks," they explain the behaviour of "biological organisms" as being the result of the relationship and interactions between these organisms and their specific environments.

While both approaches are concerned with the concept of degrees of freedom (Davids *et al.,* 2007), these degrees of freedom are applied within specific contexts. And, it is in this contextual application that their subtle differences reside.

Beek *et al.* (2003) and Williams and Ward (2007) offer a helpful distinction between these two approaches; while ecological psychology is mostly concerned with educating attention and gaining control over the degrees of perceptual freedom that are required to effectively perform a motor task, dynamic systems theory is concerned with controlling the various degrees of freedom (other than, but not excluding perception) that are important to the superior performance of this task. To further analyse these approaches, a short synopsis of each approach is provided hereafter:

#### 5.3.2.1 Ecological psychology

From the ecological perspective, the process of "educating attention" is seen as an integral part to learning and the subsequent skilled performance (Beek *et al.,* 2003; Hodges *et al.,* 2006; Williams & Ward, 2007). In this process, specific sources of information needed for the correct execution of the task (also known as specifying higher order invariants/sources of information) are identified (while reducing nonspecifying information) and utilised to effectively perform the task (Beek *et al.,* 2003; Savelsbergh *et al.,* 2004; Williams & Ward, 2007). Closely associated to the concept of educating attention is the process of mastering the perceptual degrees of freedom. In fact, Savelsbergh *et al.* (2004) show that mastering these perceptual degrees of freedom is required to educate attention.

Therefore, mastering perceptual degrees of freedom can be described as the "freezing" followed by a later, gradual "freeing" and an eventual, subsequent "exploitation" of perceptual degrees of freedom (Savelsbergh *et al.,* 2004; Williams & Ward, 2007). Interestingly, while both Huys *et al.* (2004) and Savelsbergh *et al.* (2004) make note of this freezing, freeing and exploiting degrees of freedom in motor control and coordination, Savelsbergh *et al.* (2004) then cite the work of Savelsbergh and van der Kamp (2000) who applied these processes to perception.

Savelsbergh *et al.* (2004) provide an excellent description of these processes in more practical terms. When freezing perceptual degrees of freedom, only one source of information out of the total number of information sources available is chosen to regulate action. As this "coupling" is reinforced through practice, this increases the chances of the same outcome occurring under a similar set of circumstances (referred to as constraints). An example of this is where a soccer player is taught to stop a ball with their foot, when this ball is kicked along the ground and where the conditions are stably maintained (Savelsbergh *et al.,* 2004).

The second phase involves the freeing of the perceptual degrees of freedom whereby practice is performed under various different conditions or constraints. This assists the individual in establishing a collection of different couplings for this specific task. Therefore, as the circumstances or constraints change, so the participant can choose a different coupling or set of actions. To illustrate this progression, the soccer player is now taught to stop a ground-level ball with their foot when the ball is passed along the ground in a different way or when the ground is wet (Savelsbergh *et al.,* 2004).

The final phase involves the exploiting of the perceptual degrees of freedom. The individual who has advanced in skill can now utilise the information received from the environment to either carry out the original skill (stopping a ground-level ball with their foot) but may also use this information to perform other skills such as ball heading or passing the ball with one touch (Savelsbergh *et al.,* 2004).

Essentially, what can be gained from these explanations is as the participant practices their skills and becomes more adept in the execution thereof, their ability to incorporate more of the abundant information cues inherent to the relevant environment presented to them improves and they therefore have a wider array of information/action choices to make a selection from. In this way, skilled individuals are more capable and able to perform motor actions in response to a wider array of informational, perceptual and environmental stimuli.

This much is admitted by Araújo (2007:76) who, when describing the development of expert performance in sport, says that to successfully achieve this *"…requires establishing a link between information and movement in the short term, and refining that link in the long term."*

#### 5.3.2.2 Dynamical systems theory

According to the dynamical systems theory, the execution of physical tasks or movement can be defined as coordinated motor patterns (Thomas *et al.,* 2001) or patterns of movement (Coker, 2004) that self-organise as a reaction to the task-specific constraints inherent to the movement or task (Thomas *et al.,* 2001; Coker, 2004). Thomas *et al.* (2001) provide the best description of the three characteristics that are inherent and unique to the dynamical systems theory. These are that skilled movement is not as a result of maturational processes, that specific internal and external influences cooperate to control movement, and finally, that movement is not cognitively controlled or influenced (Thomas *et al.,* 2001).

According to the dynamic systems theory, there are specific constraints that are inherent to movement. These constraints are commonly divided into three categories and are described hereafter. Once again it needs to be heeded that while a specific study is credited for the specific heading of the constraint, these headings have been found in all the studies:

1) Task constraints (Araújo *et al.,* 2004:413).

This entails aspects such as the specific tools or implements needed for participation in the sport, the rules of a specific sport, the task goal, and even extends to field markings and the like (Thomas *et al.,* 2001; Araújo *et al.,* 2004; Coker, 2004).

2) Organismic constraints (Araújo *et al.,* 2004:412).

This refers to the physical aspects of the participant. These include structural characteristics such as body composition and weight as well as the cardiovascular, neural and muscular systems. Functional characteristics include motivation, emotions and cognition (Thomas *et al.,* 2001; Araújo *et al.,* 2004; Coker, 2004).

3) Environmental constraints (Araújo *et al.,* 2004:412).

This includes aspects such as gravity, lighting, temperature and can also include the auditory information available to the individual (Thomas *et al.,* 2001; Araújo *et al.,* 2004; Coker, 2004).

With all movement tasks, there are many ways in which to act or move (Thomas *et al.,* 2001). The central tenet of dynamic systems theory is that movement is the result of gaining control over the numerous (mechanical) degrees of freedom that are available to the individual. Through the interaction between these degrees of freedom and the associated constraints (task, organismic and environmental), control can be exerted over the mechanical degrees of freedom that are not required, simple and stable movement patterns can emerge, with effective and proper movement as the result (Thomas *et al.,* 2001; Araújo *et al.,* 2004).

Or, put another way; acquiring and developing movement coordination is a process whereby the redundant or non-essential degrees of freedom are discarded or disregarded, the essential degrees of freedom are constrained, stimulated and controlled, with the resulting movement being more controlled and skilful (Williams & Ward, 2007).

In conclusion of this section; from the literature it is clear that both perceptual-cognitive and perceptual-motor approaches employ different methodological approaches. Whereas perceptual-motor approaches are attuned to perception and subsequent motor action, they give the cognitive aspects of movement very little consideration. Perceptual-cognitive approaches in turn focus on perception and cognition and are not overly concerned with how these decisions are physically implemented (Williams & Ward, 2007).

But, while Williams and Ward (2007) are of the opinion that it would be very difficult to combine these two approaches, they do make mention of the work of Davids *et al.* (2001) that provides further insight into the attempts made in literature to combine these divergent methodologies. Another example is that of Starkes *et al.* (2004). In describing their model of the acquisition and retention of perceptual-motor expertise, Starkes *et al.* (2004:259) explain that it *"…attempts to capture the constant transition that occurs in perceptual-cognitive and perceptual-motor behaviour as skill acquisition occurs, as well as how skilled behaviours may be retained following peak performance."* In literature reviewed subsequent to their study, commentary on their model was not encountered; although that does not preclude the fact that such commentary probably does exist.

It must be noted regarding the dynamical systems theory that it has been utilised and applied in a variety of different disciplines ranging from biomechanics (Davids *et al.,* 2000; Glazier *et al.,* 2003) to psychology (see preceding references as evidence). The application of this theory to various disciplines is noted, but, the inclusion of this theory within this section is justified by; 1) this theory's close and intimate association and interaction with ecological psychology as well as; 2) the overwhelming evidence garnered from the literature pertaining to sport psychology. Therefore, the dynamical systems theory is a psychological construct in its own right.

## 5.4 MENTAL TOUGHNESS

To attain the highest levels in elite sport, resilience, perseverance and a "thick skin" are required. Sport is not only about the requisite physical ability and psychological characteristics, attributes and skills such as motivation, commitment and perceptual-cognitive/motor abilities, but, pertinently, it is about having control over conflicting emotions and the ability to properly harness and direct emotions such as aggression, anger, self confidence and even fear.

Within the literature, a relatively recent, all-encompassing construct has emerged, namely that of mental strength and toughness. This construct has received some interest in rugby (Abbott & Easson, 2002; Luger & Pook, 2004) which is understandable, since, by its nature rugby is a particularly physically taxing and demanding (and aggressive) activity that is often described as being a collision sport (Hattingh, 2003; Gabbett, 2006; Gabbett & Domrow, in press). Also, in reviewing the distinction made by this study and guided by Baker and Horton (2004) between the psychological abilities needed to firstly achieve and then demonstrate high levels of ability in sport, it must be said that mental toughness falls into both categories.

Therefore, mental toughness has a strong influence on excellence in an endeavour such as competitive sport and rugby where incredible demands are placed on participants to excel at the highest levels while performing under physically and mentally demanding conditions (Fourie & Potgieter, 2001; Smith, 2002; Jones *et al.,* 2007). To become a champion, talent is simply not enough; mental abilities and personal characteristics are often the difference between the fine line that separates success and failure (Calder, 2007).

The importance of mental toughness cannot be overemphasized. In the study of Gould *et al. (*2002), 73% of the respondents identified mental toughness as being important to performance. The most notable aspect of this study is that it was performed on a sample group consisting of ten Olympic champions. These champions represented nine Olympic sports and the combined total of the Olympic medals won by these athletes was 32. These medals consisted of 28 gold medals, 3 silver medals and 1 bronze medal. Also included in the study were ten coaches involved in the development of these Olympic champions, as well as ten significant others (one for each athlete). These significant others consisted of siblings, fathers, mothers and one significant other. Therefore, this study represented the “best of the best” and a major implication of this study is that mental toughness is critical to performance in elite sport.

But, as Cooper and Goodenough (2007:1) ask *“What is mental toughness anyway?”*

In referring to the sentiments of Jones *et al.* (2002), Jones *et al.* (2007:244) say that mental toughness is *"…one of the most used but least understood terms in applied sport psychology."* Jones *et al.* (2002; 2007) go on to note that numerous attempts are found in literature that try to define mental toughness or try to describe how to develop mentally tough individuals. They lament the fact that these widely-differing definitions and explanations only serve to cause more confusion.

Perhaps, in an attempt to define mental toughness, the attributes or characteristics thereof need to be considered? Once again the problem of the vagarious nature of this concept is highlighted by Jones *et al. (*2002) who provide a host of studies listing the characteristics of mental toughness; they opine that from the evidence in literature that they reviewed, any desirable or attractive psychological characteristic that assists in achieving success in sport has been considered as being mental toughness.

For the sake of clarity and consistency, the findings of recent studies focussing on mental toughness have been reviewed, with particular reference to these studies' listings of the inherent attributes of mental toughness. Thereafter, and as a conclusion to this sub-section, the findings of two of the most recent publications in literature have been provided and contrasted.

1) Fourie and Potgieter (2001) define mental toughness as possessing the ability to deal with pressure and hardship, under conditions characterised by high mental and physical demands, in ways that that won't adversely hamper nor have a negative impact on performance. Furthermore, under this competitive pressure, mentally tough athletes remain composed and can continue to think in realistic, positive and productive ways. These authors also note that mentally tough individuals require the ability to remain simultaneously brave and committed, all the while being of good spirits.

The attributes of mental toughness listed in their study include attributes such as psychological hardiness, discipline, competitiveness, goal directedness and preparation skills, motivation, confidence, mental, cognitive and physical ability, coping skills, team unity, and finally, ethics and religiosity. Overall, the athletes considered perseverance as most significant, while the coaches felt that concentration was most important.

2) Jones *et al. (*2002:209) define mental toughness as *"…having the natural or developed psychological edge that enables you to:*

- *Generally, cope better than your opponents with the many demands (competition, training, lifestyle) that sport places on a performer.*
- *Specifically, be more consistent and better than your opponents in remaining determined, focused, confident, and in control under pressure."*

Jones *et al. (*2007) observe that this definition was subsequently cited and endorsed by Bull *et al. (*2005), and Thelwell *et al. (*2005). Both Bull *et al.* (2005) and Thelwell *et al.* (2005) also endorse (with Thelwell *et al.* (2005) citing) the attributes of mental toughness originally proposed by Jones *et al. (*2002) and that are listed hereafter.

The attributes of mental toughness as proposed by Jones *et al. (*2002) are, 1) retaining focus in-spite of life distractions; 2) retaining a task-specific focus in spite of the distractions from competition; 3) not being negatively influenced by others' performances; 4) having a resolute belief in one's ability to succeed and to achieve goals; 5) a belief of superiority over opponent(s); 6) enduring emotional and physical pain during competition and training while still maintaining effort and proper technique; 7) enjoying competition pressure; 8) possessing an unquenchable motivation and desire for success; 9) being able to regain psychological control following unanticipated events during competition; 10) accepting and coping with competition anxiety; 11) the ability to rebound from bad performances and maintaining a resolute determination to succeed, and finally; 12) the ability to turn one's sport focus on and off at the proper times.

3) Golby and Sheard (2004), in quoting the opinion of Loehr (1986), refer to mentally tough performers as those individuals who are disciplined in their thinking and who are able to calmly respond to pressure and in so doing maintain a relaxed outlook. Also, mentally tough individuals possess the proper attitudes concerning a multitude of issues such as competition, problems and others.

Specifically, they then list Loehr's (1986) original mental toughness attributes as being those of, 1) an unyielding attitude; 2) focused and controlled attention; 3) emotional control over feelings such as frustration, anger and fear and the ability to cope with events that are out of one's control; 4) positive visualisation and imagery; 5) enjoyment and fun; 6) self-confident in the knowledge that one can be successful, and; 7) perseverance and motivation.

Furthermore, the studies of both Bull *et al.* (2005) and Thelwell *et al.* (2005) are highly informative and of great value in further expanding the concept of mental toughness.

#### 5.4.1 Recent studies on mental toughness

It is the more recent study of Jones *et al. (*2007) and the work of Cooper and Goodenough (2007) that provide the most relevant information on this construct and these are reviewed in this section.

##### 5.4.1.1 Mental Toughness Framework (Jones *et al.,* 2007)

In a follow-up on their study in 2002, Jones and colleagues (2007) attempt to develop a mental toughness framework for sport. The subsequent results of their study are most helpful. While their latest study endorsed the definition of mental toughness in their previous work in 2002, they were in fact successful in developing a mental toughness framework with their recent work.

Their sample group consisted of eight *super-elite* (those falling into this category are recognised officially as being the best in the world) sports participants who between them had amassed eleven world championship titles and seven Olympic gold medals. The sports represented in the sample were athletics, cricket, pentathlon, squash, rugby union, judo, boxing, triathlon, swimming and rowing. Also included in the sample were sport psychologists and coaches, all of whom had experience in dealing with super-elite athletes.

The mental toughness framework of Jones *et al.* (2007) is a valuable tool in examining and developing this construct. It is made up of four main dimensions, but contains thirty attributes that are assigned and ranked under these dimensions. This framework is described briefly hereafter, but no specific rankings are provided. Furthermore, the attributes described are in summarised form, in no particular order. For an in-depth review of the rankings, please consult the original study:

1) Attitude/mindset dimension (Jones *et al.,* 2007:250)

This contains two subcategories, i.e.: focus and belief.

1.1) The focus subcategory highlights the following attributes: making the number one priority in your life that of achieving your sport's goal, the ability to switch on and off in life, and a focus on long-term goals as opposed to short-term gains.

1.2) In the belief subcategory the following attributes are encountered: the belief that any obstacle can be overcome, the belief that intense desire and hunger will result in the fulfilment of potential, and an unwavering belief in self, and a remembrance of path travelled to success (Jones *et al.,* 2007).

2) Training dimension (Jones *et al.,* 2007:250)

This has three subcategories, i.e.: control of the environment, pushing oneself to the limit and using long-term goals as motivation.

2.1) The controlling of the environment subcategory has the following attributes: use a difficult training environment or circumstance to one's own advantage, and not being controlled, but remaining in control.

2.2) In the subcategory of pushing oneself to the limit, the following attributes are encountered: Opportunities presented in training to beat other people must be used to the fullest benefit, and enjoying training that hurts.

2.3) In the long-term goals subcategory the following attributes are noted: to keep reminding oneself of your goals and desires when training gets physically and mentally tough and to have the patience and self-discipline required when training for each developmental stage (Jones *et al.,* 2007).

3) Competition dimension (Jones *et al.,* 2007:251)

This dimension has six subcategories, i.e.: regulating performance, belief, staying focused, handling pressure, controlling the environment and awareness and control of thoughts and feelings.

3.1) In the regulating performance subcategory, the following attributes are noted: raising one's performance when needed, and being able to take advantage of the key moments in competition (possessing a "killer instinct").

3.2) In the belief subcategory, the following attributes are found: rebounding from mistakes and remaining committed to the performance goal until the very end.

3.3) The staying focused subcategory contains the following attributes: retaining a self-absorbed focus in the face of external distractions, being totally focused on the job at hand in spite of distractions, and focusing on processes as well as outcomes.

3.4) The handling pressure subcategory lists the following attributes: correct decisions and choices of options or alternatives for the best performance under pressure, coping with changes under competition pressure, loving competition pressure, and coping with anxiety in pressure circumstances.

3.5) In the controlling the environment subcategory, the following attributes are found: utilising all the aspects of a challenging competition environment to one's own advantage.

3.6) The awareness and control of thoughts and feelings subcategory has the following attributes: being conscious of wrong or damaging thoughts and feelings and adjusting them to perform at one's best (Jones *et al.,* 2007).

4) Postcompetition dimension (Jones *et al.,* 2007:251)

This contains two subcategories, i.e.: handling success and handling failure.

4.1) In the handling of success subcategory, the following attributes are provided: knowing how to handle success in a rational manner, and knowing when to celebrate your successes and victories but then also knowing when to stop and to refocus.

4.2) In the handling of failure subcategory, the following attributes are given: using failure as a motivation towards achieving further success, and rationalising and learning from failure (Jones *et al.,* 2007).

As can be seen, Jones *et al. (*2007) have provided a comprehensive framework that can be used to further describe mental toughness as well as to assist in the development of mental toughness.

#### 5.4.1.2 Elite Athlete Development Model (Cooper & Goodenough, 2007)

This Elite Athlete Development Model of Cooper and Goodenough (2007) (also called the "Zoning Pyramid") is a valuable tool not only to ascertain the current mental status and level of toughness in an individual, but furthermore, to assist in developing mental abilities so as to improve and develop these in the individual (and possibly the team where applicable). This model is best described as follows:

The Elite Athlete Development Model offers a substantially different perspective to that offered by the traditional sport psychology approaches, and is based on the concept of Meta-Coaching. Meta-Coaching is in turn based on several neuro-semantics models, principally the Meta-States Model, the Matrix Model and the Axes of Change. These models come from the fields of developmental psychology, cybernetics, general semantics, neuro-linguistic programming (NLP), cognitive behavioral sciences, cognitive linguistics, neuro-sciences, and system dynamics. As a result, neuro-semantics can largely be seen is an inter-disciplinary field. In 1994, L. Michael Hall, Ph.D., developed the first and core model of neuro-semantics, called the Meta States Model. Neuro-semantics is a newer, more modern extension of NLP and has added a new level of professional ethics (M. Cooper, personal communication, 2007).

Accordingly, this model is perfect for the sporting arena, since it allows for generative mental development to occur and further allows for attention to be focused on working on what the athlete wants to develop. This is in contrast to traditional psychology that primarily focuses on remedial mental work. Therefore, according to this model, coaching assumes that a client is a talented and fully functioning individual that will benefit from developing new behaviours, skills and learning’s through a facilitative process that is non-directive. This non-directive facilitation is aimed at the client or sports person being guided to find their own unique strategies and learning's to build the 13 skills that make up this Elite Athlete Development Model by Cooper and Goodenough (2007) (M. Cooper, personal communication, 2007).

In sport there are common questions asked regarding mental strength and toughness. Questions are frequently asked regarding the behaviors that coaches should look for in new athletes so as to determine their potential in sport, or, the specific steps that need to be taken to improve mental strength and toughness (M. Cooper, personal communication, 2007). The Elite Athlete Development Model of Cooper and Goodenough (2007) breaks down “mental strength” into thirteen specific foundational skills and then provides benchmarks for these skills (M. Cooper, personal communication, 2007; Cooper & Goodenough, 2007).

These benchmarks allow the coach to measure each skill on a scale from zero to five. The athlete can receive feedback on specific strengths and weaknesses and then have targeted coaching sessions to develop these skills. The advantage of this model lies in the fact that these skills can be measured, allowing this model to be used as an assessment tool. Athletes benefit from being able to be coached immediately on their areas requiring specific attention. What this means for sports participants (teams and individuals) is that the positive impact on performance will be quicker than what would normally be expected were these unique interventions not applied (M. Cooper, personal communication, 2007).

The thirteen skills were built on interviews with former and current South African elite athletes and can be regarded as a model of excellence. These thirteen skills of the Elite Athlete Development Model of Cooper and Goodenough (2007) are listed and briefly described hereafter:

1) Performing from one’s highest intentions (Cooper & Goodenough, 2007:223)

Associated with this is the main reason for one’s participation in a sport or activity. This provides the impetus to continue within a sport or activity. It entails being able to know and to identify as well as to operate from the intentions that one has. It also entails the ability to move towards one’s highest intentions (Cooper & Goodenough, 2007).

2) Strong work ethic (Cooper & Goodenough, 2007:225)

This entails being able to put in regular and sustained hard work and effort to reach one's goals. It also entails goal setting ability as the ability to see these goals through (Cooper & Goodenough, 2007).

3) Internally referent (locus of control) with external check (Cooper & Goodenough, 2007:227)
Makes decisions and thinks, based on what one knows, understands and believes. This decision making process can entail checking with others, but is primarily geared toward a ratio of twenty five percent external focus and a seventy five percent internal focus (Cooper & Goodenough, 2007).

4) Clear distinction between self-confidence and self-esteem (Cooper & Goodenough, 2007:230)
This is the ability to distinguish between one's skills and ability to perform, which is self-confidence, and one's value and worth, which is self-esteem (Cooper & Goodenough, 2007).

5) Resilience (Cooper & Goodenough, 2007:233).
This entails the ability to rebound from a bad performances or setbacks in a short period of time and to not hold on to the negative associations of these setbacks but to learn the inherent lessons contained in the setbacks. This also entails the ability to successfully cope with negative life events that hamper or hinder performance or progress (Cooper & Goodenough, 2007).

6) Effectively manages anxiety and confidence (Cooper & Goodenough, 2007:235).
This means that one is able to manage and balance the to-and-fro effect that anxiety and confidence can have on an individual and on performance (Cooper & Goodenough, 2007).

7) "Un-insultability" (Cooper & Goodenough, 2007:237).

This means possessing a strong sense of self that views both criticism and support as things that don't affect self esteem or perception (Cooper & Goodenough, 2007).

8) Mental positioning (Cooper & Goodenough, 2007:239).

This is the ability to have or to adopt different perspectives on the game or event and to understand one's own specific role within the game and to fulfill it. Furthermore, this also entails being able to disassociate oneself from the game to monitor its progression (Cooper & Goodenough, 2007).

9) Engages in meaningful and high-quality practice (Cooper & Goodenough, 2007:241).

To approach practice and training in practical ways that develop skills and that help with achieving goals but that also promotes team building and motivation. This also means that this practice should stimulate a sense of consistent improvement. Also, practice should be complementary to the specific goals of the player (Cooper & Goodenough, 2007).

10) Quality mental preparation before an event (Cooper & Goodenough, 2007:243).

This is the ability to effectively use visualisation techniques that effectively capture the anticipated match environment and that suitably prepare the mind and body (Cooper & Goodenough, 2007).

11) The ability to simplify (Cooper & Goodenough, 2007:245)

The ability to identify the "critical success factors" required to be competitive from one's own understanding of the game (Cooper & Goodenough, 2007).

12) Activity identity-shaper (Cooper & Goodenough, 2007:247)

One's ability to choose a self identity that is initiated and empowered from within. This self identity assists in achieving one's goals and (maximum) potential (Cooper & Goodenough, 2007).

13) Flow state management (Cooper & Goodenough, 2007:249).

This entails being "in the zone" and the ability to at will enter into a state of utmost involvement or engagement with an activity or experience. To be able to "switch" this ability or "zone" on or off at will. Cooper and Goodenough (2007) acknowledge the work of Csíkszentmihályi (1991) in this regard (Cooper & Goodenough, 2007).

Therefore, in conclusion of this sub-section, every one of the thirteen skills listed is then benchmarked on a scale from zero to five. Once this benchmarking is complete, the process of improving these scores through coaching can commence. But, pertinent to remember is that this model can be used as an assessment tool, hence the value and appeal of this model to talent identification and development.

## 5.5 SUMMARY AND APPLICATION TO TALENT IDENTIFICATION AND DEVELOPMENT

The discussion serves as a summary of this chapter and will focus on three issues:

1) The interrelation of the psychological and mental skills, attributes and abilities mentioned examined throughout the course of this chapter. In particular, the relevant and possible influence that these skills and abilities have on one another, as well as their possible impact on talent identification and development are considered.

2) A review of the possible incorporation of the Mental Toughness Framework of Jones *et al.* (2007) and the Elite Athlete Development Model of Cooper and Goodenough (2007) into the talent identification protocols and subsequent development processes.

3) A discussion centering on the possible inclusion of perceptual-cognitive and perceptual-motor skills tests in the talent identification protocols and processes.

### 5.5.1 Interrelation of psychological skills, attributes and abilities

From the literature reviewed in this chapter, the different constructs, theories, attributes and skills seem to vary with regards their application and relevance, but, it is clear that they have an influence and impact on one another in various manners.

#### 5.5.1.1 Motivation, commitment, practice and enjoyment

When considering task and ego-orientations as well as intrinsic and extrinsic motivations as promoted by the Achievement Goal Theory (AGT), the Profile of Goal Orientation Questionnaire (PGOQ), the Self Determination Theory (SDT), The Hierarchical Model of Intrinsic and Extrinsic Motivation (HMIEM) and the Elite Athlete Development Model (EADM) respectively, it is obvious that a balance between these orientations and motivations is needed to reach elite status in sport. This much is confirmed by Van Rossum and Vergouwen (2003) in Van Rossum and Gagné (2005), who, in their study on Dutch, South African and Australian national field-hockey teams found results implying that both the ego and task aspects of sport achievement motivation are judged to be important or of value by elite athletes.

As an illustration of this fact; as part of their Mental Toughness Framework (MTF), Jones *et al. (*2007:250) propose in their in subcategory of *"…pushing yourself to the limit"* that in practice one must enjoy the opportunities presented to beat other individuals. It can be deduced from this that practice can (and should?) be considered a competition "dress-rehearsal" and therefore practice, training and competition require both task-and-ego-orientations as well as intrinsic and extrinsic motivations for these competitive endeavours to be successful.

This consideration applies especially to sports that require direct opposition to train. In wrestling, as reflected by Hodges and Starkes (1996), an individual is required to train against another individual. It stands to reason that in sports such as these, technique development is so dependent on these direct one-on-one training sessions. The assumed requirement of this kind of training is that a task/intrinsically focused perspective is needed to improve personal technique and that an ego/extrinsically focused perspective is needed in training (and competition) to beat the opposition. In fact, it is quite hard to imagine a sport where practice against opposition is not a prerequisite and where a certain amount of ego or extrinsically focused perspective is not required. Although, most of the models do insist that competitors must not be affected by their opposition and must maintain an inward, task orientated focus. But, the point remains that ego orientation is at least a part necessity.

Furthermore, in team settings this aspect is an even greater consideration. Not only does one have to concentrate on their own technique, but also the movements and patterns of their teammates and the opposition. This can be applied to most team sports and most certainly rugby; in training (simulated competition environments) and competition, while focus on own technique is vital, focus on teammates and the opposition is critical. The facts are clear; to become a champion (individually or as a team) you must beat the opposition.

To confirm the above sentiments, it was found by Baker *et al. (*2003b) that competitive settings (such as organised games) were the most valuable in developing and training aspects of performance such as decision-making and perception. The conclusion is made by this study, then, that it is undeniable that there is an inevitable or even a required amount of external focus and motivation needed to be successful or to become a champion.

Pertaining to the Deliberate Practice Theory (DPT) of Ericsson *et al. (*1993) (DPT), of the constraints listed by their theory is that a high level of effort is required so sustain this kind of practice, and that practice is not deemed inherently enjoyable. It is said that that motivation and *"…ones intent to improve"* (Ward *et al.,* 2004:232) play an important role in sustained practice and participation. This study holds to the position that motivation characterised by a more task-orientated goal perspective and biased toward intrinsic motivation is critical to persist in this kind of training.

When elaborating on the DPT further by considering the EADM, one of the skills mentioned is that of *"Performing from one's highest intentions"* (Cooper & Goodenough, 2007:223). This refers to one's main reason for participation as well as the impetus to continue in a sport or activity. Since the intention of deliberate and sustained practice is the improvement of skills, in a way this can be seen as a higher or the highest intention as proposed by EADM.

Furthermore, regarding enjoyment in practice; there seems to be a disparity regarding the role of enjoyment in sport participation and practice as proposed by the Sport Commitment Model (SCM) of Carpenter, Scanlan and colleagues (1993) in contrast to the Deliberate Practice Theory of Ericsson and colleagues (1993) which states that practice is not inherently enjoyable.

Even if Ericsson *et al. (*1993) propose that practice by its nature not enjoyable, other studies (Carpenter *et al.,* 1993; Scanlan *et al.,* 1993a, 1993b; Carpenter & Scanlan, 1998; Starkes *et al.,* 2001; Ward *et al.,* 2004; Hyllegard & Yamamoto, 2005; Weiss & Weiss, 2007) on sport and the construct of enjoyment in deliberate practice and sport participation and commitment have come up with contrary findings, suggesting that in the domain of sport, enjoyment of participation is integral to sustained adherence and success.

*5.5.1.1.1 Commonalities*

As a summary of the commonalities of the psychological and mental attributes discussed in this chapter, the following commonly encountered attributes apply: 1) work ethic, practice, motivation and goal setting (Jones *et al.,* 2002; AGT; DPT; HMIEM; EADM; MTF; PGOQ; SDT); 2) anxiety and self-confidence (Fourie & Potgieter, 2001; Jones *et al.,* 2002; Golby & Sheard, 2004; EADM; MTF); 3) resilience, commitment and hardiness (Fourie & Potgieter, 2001; Jones *et al.,* 2002; Golby & Sheard, 2004; EADM; MTF; SCM); 4) mental preparation and visualisation (Golby & Sheard, 2004; EADM), and; 5) attention and focus (Jones *et al.,* 2002; Golby & Sheard, 2004; EADM; MTF)

Therefore, it is clear that all aspects of motivation, commitment, practice and control over emotions play an important role in most of the studies, models and theories presented in this review, and therefore they can be regarded as being interrelated on this level.

As confirmation if this, the uniquely South African study of Schuman *et al. (*2005) is presented. In this study, 454 sports participants and 114 coaches were interviewed regarding the importance of motivation and related factors in sport. The following mix of intrinsic and extrinsic motivational, commitment-related and enjoyment factors were identified by Schuman *et al.* (2005:143) as being important in motivation: *"…encouragement to perform better; goal setting; enjoyment and pleasure in sport; activation; self-efficacy; communication between coaches/players; reward for achievement; self confidence in players; praise; individual attention; effective coaching methods and techniques; competition; and being intrinsically motivated."*

This study of Schuman *et al.* (2005) could very well be viewed as a summary of the whole preceding discussion in this chapter.

**5.5.1.2 Role of practice in perceptual-cognitive and perceptual-motor skills**

*5.5.1.2.1 Practice and perceptual-cognitive skills*

The perceptual-cognitive advantages experienced by elite athletes over non-elite athletes in the procedural, declarative and strategic domain and sport-specific knowledge that they possess (French & McPherson, 1999; Helsen & Starkes, 1999; Kluka, 1999; Starkes *et al.,* 2001; Thomas *et al.,* 2001; Janelle & Hillman, 2003; Hodges *et al.,* 2006), as well as their advantage over lesser skilled players in pattern or information recall, retention and recognition abilities (Williams *et al.,* 1994, 2003, 2004; Helsen & Starkes, 1999; Tenenbaum *et al.,* 1999; Williams, 2000; Starkes *et al.,* 2001; Baker *et al.,* 2003b; Lyoka & Bressan, 2003; Ward & Williams, 2003; Williams & Ward, 2003, 2007; Abernethy *et al.,* 2005; Hodges *et al.,* 2006; Vaeyens *et al.,* 2007) has been well documented.

Prolonged exposure to a domain is vital for these skills to be developed and improved, with deliberate and persistent practice contributing to this process. Therefore, from the evidence presented above and before, practice assists with training perceptual-cognitive skills such as sport-specific knowledge and pattern recall and recognition. The role of practice in the other perceptual-cognitive skills and abilities was also considered.

Aspects such as practice and improving anticipation through improving advanced cue utilization (Williams & Ward, 2003; Williams *et al.,* 2003, 2004) and practice and visual search behaviours and strategies (Vaeyens *et al.,* 2007) were studied with certain practice effects found. Other aspects such as pattern recognition and situational probabilities have received little attention as such (Williams & Ward, 2003; Williams *et al.,* 2004).

*5.5.1.2.2 Practice and perceptual-motor skills*

As was demonstrated, practice is critical to the process of educating attention where perceptual-motor abilities are improved by a process where perceptual information is frozen and subsequently freed and exploited (Savelsbergh *et al.,* 2004; Williams & Ward, 2007).

When considering motor skills and movement, it can be said that movement is the result of gaining control over the numerous (mechanical) degrees of freedom that are available to the individual. Through the interaction between these degrees of freedom and the associated constraints (task, organismic and environmental), control can be exerted over the mechanical degrees of freedom that are not required, simple and stable movement patterns can emerge, with effective and proper movement as the result (Thomas *et al.,* 2001; Araújo *et al.,* 2004). It is once again quite obvious that practice is essential in promoting the gaining of control over the degrees of freedom and would be paramount to both assist and adjust to the constraints inherent to movement within the specific context.

While it is debatable within the literature as to whether practice can assist with visual system improvement, some limited evidence of this fact has been presented (Meir, 2005; Cooper & Goodenough, 2007).

##### *5.5.1.2.3 Practice and skill transfer*

Evidence of a transfer effect in hand-eye coordination was found by du Toit *et al.* (2006a) and Grassi *et al.* (2006), underscoring the important role of practice in developing these perceptual-motor skills. But, limited evidence of role-specific perceptual-cognitive skill transfer (Smeeton *et al.,* 2004; Abernethy *et al.,* 2005; MacMahon *et al.* 2007) has also been encountered. This study adopts the position that it is certainly feasible that practice assisted in developing the perceptual-cognitive skills in the initial role or domain, and that it was these practiced skills that transferred between the similar roles found in the preceding studies.

#### 5.5.1.3 Impact of the interrelatedness on talent identification and development

The impact of the interrelatedness of these factors on talent identification and development is vast. Talent identification more often than not identifies those individuals in possession and currently applying the abilities, attributes and skills mentioned in this section. But, importantly, by identifying those in possession of these factors, talent identification can assist in the further development of the individuals in these factors and others.

For example, motivation, commitment, practice and mental toughness could have, in all likelihood, contributed to the individual developing their perceptual-cognitive and perceptual-motor abilities so that these aspects, in conjunction with well developed physical aspects, place the individual in a favourable position to be identified or selected. Thereafter, they stand the good chance of being included in further developmental programs that improve these abilities even more. The process can therefore be regarded as a closed-loop system, i.e.: complementary and most certainly reciprocal.

In sum: from the preceding passages, it is clear that talent identification should acknowledge the likelihood that the interrelations of these factors have assisted in the previous development of those individuals to the point where they are currently identified or selected for further development.

Of course, these sentiments are not shared by everyone, as chapter four and six show. Aspects such as early physical maturation, practice and others (chapter four) and the perceived inadequacies of current talent identification approaches (chapter six) are issues that are consistently highlighted as being complicating factors within the field of talent identification.

And there are other considerations in this regard, like those of Morris (2000) and Williams and Reilly (2000b). These authors are of the opinion that there are no specific personality profiles that exist within sport and that can predict future achievement. With that said, it is the opinion of this study, however, that the Elite Athlete Development Model (EADM) of Cooper and Goodenough (2007) and the Mental Toughness Framework (MTF) of Jones *et al.* (2007) have gone a long way in providing at least some semblance of assessment, with the EADM more so. These sentiments are further elaborated upon next.

### 5.5.2 Incorporation of mental toughness measures in talent identification protocols

Jones *et al. (*2007) propose their impressive Mental Toughness Framework by which the elements and attributes of mental toughness and strength have been exhaustively researched and described. This model serves to identify and develop these aspects and attributes within the individual. In theory, this framework can be used to search for these characteristics within individuals.

But, to what extent can these attributes be objectively measured and further developed?

The specific views of Williams and Reilly (2000b) are that while studies have shown that aspects such as mental toughness and aggression have been found to be the difference between successful and less successful participants, there are concerns with the methodological aspects arising from these studies.

But, this study's view on these proposals of Williams and Reilly's (2000b) is one of respectful disagreement. Abbott and Easson (2002) provide a simple and straightforward, rugby specific performance profiling model developed by Butler (1996) that measures not only physical parameters and technical aspects of a rugby player but also psychological skills and attitudes that can be seen as pertaining specifically to mental toughness. This profiling takes the form of self assessments that are valuable because not only does it provide for the assessing of individual players but also provides that individual players assess themselves. This can lead to accountability and self-responsibility for the improvement of these factors. This performance profiling model could quite successfully be used in talent identification protocols and practices. Furthermore, Abbott *et al.* (2007) provide evidence of studies finding that aspects such as commitment, goal setting and imagery have all been found to differentiate between more and less successful sports participation.

It is therefore this study's contention that the Elite Athlete Development Model of Cooper and Goodenough (2007) can successfully be incorporated into talent identification and selection protocols, and can further be highly effective when incorporated into talent development programs. This model measures all of these differentiating aspects mentioned by Abbott *et al.* (2007), and more. Furthermore, while this model can present your current profile with regards to how you score in each of the thirteen categories, it can also show you what to do to improve. The Mental Toughness Framework of Jones *et al.* (2007) is also an option, but, it is not as much of an assessment tool as the model of Cooper and Goodenough (2007).

That a mental toughness assessment tool is needed is a concession that Jones *et al.* (2007:262) make when they admit that *"…there is a need to develop a valid and* *reliable measure of mental toughness based on a sound knowledge base of dedicated empirical research."* They do however state that the findings of their study could assist in developing such a tool. Whether Cooper and Goodenough's (2007) model meets the requirements of having a solid empirical research base seems to be a moot point in this case. From what they have provided through their interviews and further implementation of aspects from many complementary fields, as well as their own, and with these fields having an assumed satisfactory empirical base, their model is certainly exhaustive, robust and complete.

### 5.5.3 Recommendations regarding the inclusion of perceptual-cognitive and perceptual-motor tests within talent identification protocols

Williams and Reilly (2000b) are strong supporters for the possible role that perceptual-cognitive skills can play in talent identification. A number of studies and texts have reviewed the common methods and techniques used to measure and evaluate perceptual-cognitive and perceptual-motor abilities in sport. These methods are evaluated hereafter:

#### 5.5.3.1 Film and video-based simulations, virtual reality and field-based methods

Film and video-based simulation methods have been used to accurately capture performance in sport (Williams & Ericsson, 2005; Hodges *et al.,* 2007; Ward *et al.,* 2006; Williams & Ward, 2007). The advantage of using film or video simulators is that these methods can consistently and accurately reproduce action sequences and in so doing facilitate proper and objective measurement of performance (Williams & Ericsson, 2005; Williams & Ward, 2007), with Ward *et al.* (2006) stating that recent improvements in the technology used for these methods have allowed researchers to improve the "ecological representativeness" of the tasks under investigation.

Virtual reality or field-based methods have also been used (Williams & Ericsson, 2005; Ward *et al.,* 2006; Hodges *et al.,* 2007; Williams & Ward, 2007), but there are questions as to whether virtual reality or field-based methods provide the same level of benefit or advantage over film and video-based methods (Williams & Ericsson, 2005; Williams & Ward, 2007). Delays in action-response times of the virtual reality system (Hodges *et al.,* 2007) are also a disadvantage of this method.

There are some common methods and techniques that have been used in these perceptual-cognitive to quantify or measure the performance response. These include verbal and written responses, pressure sensitive mats, joysticks and even voice activated responses (Ward *et al.,* 2006; Hodges *et al.,* 2007). But, according to Williams and Ericsson (2005) and Williams and Ward (2007), the most common measures to measure performance are those of, 1) eye-movement recording and visual occlusion techniques, and; 2) protocol analysis (also used during or subsequent to live game or task scenarios). While Williams and Ericsson (2005) do make mention of other methods, the specific focus on the afore-mentioned examples as provided by Williams and Ward (2007) will guide this analysis.

*5.5.3.1.1 Eye movement recording and visual occlusion techniques (Williams & Ward, 2007).*

The systems used to evaluate abilities such as visual search strategies range from high speed cameras, eye-movement technology and head tracking devices. As with all technology there are cost implications involved, although this technology has become more affordable of late (Hodges *et al.,* 2007).

It has been determined that strategies such as gaze fixation on certain body regions, the length of these fixations and visual search paths are employed by elite performers. The specific findings of these studies are that experts generally employ less eye fixations than non-experts, but that this is also highly specific to the sport involved, where studies have also shown more eye fixations and altered search strategies in experts in different situations (Hodges *et al.,* 2006, 2007). Also, it has been found that the circumstances dictate the search strategies and eye fixations employed by experts (Vaeyens *et al.,* 2007).

Spatial (removing specific events or features in a display) and temporal (removing vision at specific times in the execution of an action) occlusion techniques are also used to measure the ability of elite performers (Hodges *et al.,* 2006). Specific findings indicate that experts can determine from the body or postural cues of opponents, and even from the moments before contact with a racquet, volleyball or a football, what the intentions of these opponents are, and they can make adjustments to successfully attend to the required task or response (Abernethy & Russell, 1987; Starkes *et al.,* 2001; Williams *et al.,* 2004; Hodges *et al.,* 2006; Williams & Ward, 2007). Finally, occlusion under live conditions has also been attempted, but this is not always practical and there are other ethical, methodological and safety concerns (Hodges *et al.,* 2007).

*5.5.3.1.2 Protocol analysis (Hodges et al., 2007)*

It is the important work of de Groot (1978) where the study participants (world's best players and club level players) were required to think aloud while selecting chess moves, that is widely regarded as being of the earliest prominent expertise studies employing and promoting this method (Ericsson, 2006b; Feltovich *et al.,* 2006; Hodges *et al.,* 2007). Participants are required to think aloud and in so doing provide a verbal description of what they are thinking while solving the problems and performing the tasks presented to them (Gordon, 1992; Ericsson, 2003b, 2006b; Van Gog *et al.,* 2005; Feltovich *et al.,* 2006; Schraagen, 2006; Hodges *et al.,* 2007).

Protocol analysis has been shown to not affect the structures underpinning the thought processes (Ericsson, 2003b; 2006b), and in so doing is effective in combating the issue of reactivity, wherein the process of the verbal report generation negatively affects the cognitive aspects that are responsible for the performances observed (Ericsson, 2006b). In essence, what gets reported is what gets observed. Furthermore, the aim of protocol analysis is to determine the declarative and procedural knowledge of an individual (Gordon, 1992; Hodges *et al.,* 2007).

Two techniques of protocol analysis are generally used. These are; 1) retrospective reporting where participants are requested to verbalise their thoughts processes immediately after completion of the task, and ;2) concurrent reporting where the participants are required to verbalise their thought processes while actively busy with the problem or task (Van Gog *et al.,* 2005; Hodges *et al.,* 2007).

As mentioned earlier, protocol analysis has been used within film and video-based simulation tasks (Ward *et al.,* 2006; Williams & Ward, 2007). But, it can also be used successfully in live sport and game scenarios, as was shown earlier (Ericsson, 2003b; McPherson & Kernodle, 2003, 2007; Hodges *et al.,* 2007). In some sport-related examples of protocol analysis, during tennis live games the players were required to verbalise their thoughts between and immediately after points. This revealed the thought processes that go into dealing with the current task as well as monitoring one's own and the opposition's performance throughout the task (McPherson & Kernodle, 2003, 2007; Hodges *et al.,* 2007).

#### 5.5.3.2 Recommendations for the inclusion of these methods in talent identification protocols

The specific conclusions of Williams and Reilly (2000a) are that decision making and anticipation are required for success in soccer, with Abbott *et al.* (2007) agreeing that these factors have been shown to be significant in the differences found in performance between top players and those not at the same level. Williams (2000) go on to state that perceptual skill is a discriminating factor between more and less skilled soccer players.

In considering the inclusion of these methods in talent identification, there are practical and financial concerns; especially surrounding simulator and film-based methods. Sport, and in particular rugby, is anything but repetitive and an in-depth analysis as to the relevant scenarios mimicking or relevant to the demands of rugby would be required. This study has doubts that this would be possible.

Protocol analysis has been used as part of the process of task analysis in establishing and developing adequate talent identification test batteries and protocols, but, as a tool in measuring cognitive abilities and processes this method does hold merit. By using concurrent and retrospective protocol analysis in real-life scenarios, the thought processes of elite vs. non-elite performers could be compared to see if any notable differences that discriminate between talented and less talented individuals can be identified.

No eye-movement tracing or visual occlusion techniques were encountered in actual talent identification protocols for rugby in literature, although in soccer Vaeyens *et al.* (2007) suggest that the perceptual-cognitive tests used by their study could be used to differentiate talented from less talented players. Eye-movement tracing and visual occlusion techniques are once again associated with film and simulator based methods, highlighting the practical and financial considerations of these practices and methods. That they are used is undeniable; that they can be effectively used in mass talent identification and subsequent development processes is questionable.

This current study attempted to include perceptual-motor and perceptual-cognitive ability tests in the form of the Accuvision1000 proaction-reaction test. This was successfully accomplished, with norms established. Other studies such as du Toit *et al. (*2006a) on rugby and du Toit *et al. (*2006b) on cricket have also successfully incorporated the Accuvision1000 into their larger testing protocols. Subsequently, use of the Accuvision1000 has been questioned, but, the view is adopted that this study may very well have provided some of the first, albeit tentative steps toward the inclusion of perceptual-motor (cognitive) based testing in talent identification protocols in rugby. On the whole, the multivariate/multidisciplinary approach of including and considering psychological attributes, skills, perspectives and variables in all forms, in conjunction with physical/physiological, anthropometrical and skills tests in talent identification protocols is the best approach and therefore this status quo needs to be maintained.

# CHAPTER SIX

# TALENT IDENTIFICATION: HISTORICAL AND CURRENT PRACTICES

## 6.1 INTRODUCTION

In the preceding chapters of this study, the impact of various factors and considerations on talent identification and development were discussed and reviewed. The discussion in chapter three focused on issues such as the continuous evolution of sport and the impact of this evolution on sport in general and rugby specifically. The assumption to be made from this continued evolution of sport is that the demands on talent identification and development may very well increase. It is after all, as Pearson *et al.* (2006) say, a case of there being a greater demand placed on talent identification and development due to the increased prominence of sport from a marketing and commercial perspective.

Chapter four reviewed the physical considerations of elite performance in sport and further dealt with the nature versus nurture argument, with the consensus being that this debate may never be resolved. Also discussed were the issues of maturation and the role that an optimum environment, such as the proper support from significant others, plays in the process of nurturing and developing talent. Specific talent development models and theories were also considered. In chapter five, psychological perspectives and excellence in sport were discussed and the case made (or strengthened) for the inclusion of these aspects into talent identification protocols that are normally dominated by a focus on the physical. What this sixth chapter serves to do is to provide a delineation of what has been, what is, and what is hoped for with regards to talent identification and development.

From the literature it is quite apparent that talent identification and development is currently a prominent concern (Hoare & Warr, 2000; Wolstencroft, 2002; Reilly & Gilbourne, 2003; Abbott *et al.,* 2005; Martindale *et al.,* 2005, 2007; Tranckle & Cushion, 2006). The importance and purpose of talent identification can be summed up as follows: talent identification aims to find those individuals who have the most promise to succeed in the future, with a further consideration being the subsequent development of these promising youngsters so that they can reach their fullest potential (Williams & Reilly, 2000b; Abbott & Collins, 2002; Pearson *et al.,* 2006; Tranckle & Cushion, 2006; Button & Abbott, 2007; Vaeyens *et al.,* submitted).

Pienaar *et al.* (1998) underscore the importance of talent identification when they say that talent identification is a priority for modern sport. These sentiments are further confirmed by those who refer to talent identification and development as being priorities to sporting bodies, associations and elite programs (Hoare, 1998; Abbott & Collins, 2004; Pearson *et al.,* 2006; Williams & Richardson, 2006; Martindale *et al.,* 2007), and a concern to different countries (du Randt, 1992; Ackland & Bloomfield, 1996; Martindale *et al.,* 2007). Research on talent identification can be found in many sporting codes. The most recent studies include those on rugby (Plotz & Spamer, 2006; Spamer & De la Port, 2006), soccer (Vaeyens *et al.,* 2006), hockey (Elferink-Gemser *et al.,* 2007) and volleyball (Gabbett *et al.,* in press). Recent studies on rugby league (Gabbett, 2006) have also provided norm based information for selection.

An advantage of talent identification and subsequent development is that these can assist sporting organisations to effectively allocate valuable but scarce resources toward the development of those showing the most promise (Morris, 2000; Williams, 2000; Williams & Reilly, 2000b; Abbott & Collins, 2002, 2004; Pearson *et al.,* 2006; Button & Abbott, 2007) with an increase found in the establishment of elite player academies (Williams & Richardson, 2006; Button & Abbott, 2007). This establishment of elite academies also occurs in South Africa, where there are elite sporting academies for rugby and cricket. In fact, one sample group used for this study was from the elite TUKS Rugby Academy at the University of Pretoria.

Further considerations are those raised by Williams (2000), Williams and Reilly (2000b) and Williams and Richardson (2006) who make mention of the costs involved with the purchase and transfer of players in soccer and the impact that this has on sporting clubs and organisations. Closer to home and specific to rugby; if one looks at the current exodus of experienced provincial and international rugby players from the SANZAR nations to the wealthy European rugby clubs, this is a problem with potentially great repercussions. Talent identification and the subsequent nurturing and development of talented individuals can and must be performed in an attempt to offset the overall effect of these factors

Talent identification is an evolutionary process and practice that greatly contributes to the identification, selection and development of talented (or those showing talent) individuals for the purpose of assisting these individuals in reaching their potential and to furthermore assist sporting organisations to effectively allocate their limited resources in the most productive and beneficial way.

This chapter serves to provide a broad-spectrum view of the historical development of talent identification as well as to highlight the current views, practices and suggested practices for the purpose of providing an as in-depth and up-to-date review of this practice and discipline as possible.

### 6.1.1 Chapter Outline

*Section one: historical development of talent identification*

This sub-section consists of two parts. The first part will provide a purely historical discussion of the traditional models that have been in use in talent identification studies worldwide. The most commonly used model and method in talent identification, called the Conceptual Model of Talent Identification (Régnier, 1987 in Régnier *et al.,* 1993) is also highlighted and discussed in this section. The second part will then discuss the historical development of talent identification in South Africa.

*Section two: orientation of current study*

This sub-section will provide a brief orientation as to the position of this current study with regards to the preceding models, approaches and methods of talent identification.

*Section three: current day perspectives on talent identification*

Since talent identification is a discipline that is constantly evolving, the current day perspectives and on talent identification will be provided. This takes place by providing a brief analysis of the ongoing critiques pertaining to talent identification as well as the possible solutions to these critiques. A further consideration highlighted in chapter four will also be provided, being the concept of including genetic testing in talent identification and sport.

*Section four: SANZAR approaches to talent identification and development*

This section provides an up-to-date review of the talent identification and development methods and approaches of the rugby playing countries of South Africa, New Zealand and Australia (SANZAR). In this section the methods of these three countries are discussed and contrasted with one another.

*Section five: Summary*

This section will provide a summary of the findings and discussions of this chapter.

## 6.2 HISTORICAL DEVELOPMENT OF TALENT IDENTIFICATION

There are two landmark studies that have focused on the models commonly used in talent identification (detection) over the years worldwide, and these are the studies of du Randt, (1992) and Régnier *et al.* (1993).

Of particular interest to the South African context have been the study of du Randt (1992) that was conducted in conjunction with a team of researchers, as well as the relevant sub-sections (du Randt & Headley, 1992b; 1992d) of this particular study, that have provided guidance and direction for a great deal of research into talent identification and development.

Studies such as Hare (1999), Spamer (1999), Booysen (2002), Van Gent (2003), Van Gent and Spamer (2005), Spamer and De la Port (2006), and others, have relied on the information, findings and recommendations of du Randt and Headley (1992b; 1992d), emphasising the incredible value of this study overall.

Other studies that have also reviewed the specific findings of Régnier *et al.* (1993) are Du Rand-Bush and Salmela (2001) that reviewed the original models in Régnier *et al.* (1993), and Wolstencroft (2002), who evaluated some of these models from the perspective of their efficacy as prediction models and their role within the greater context of talent development.

An associated problem with reviewing these models is the sheer abundance of information, since these studies reviewed twelve models (du Randt & Headley, 1992b) and ten models (Régnier *et al.,* 1993) respectively. As a consequence, guidance has been taken from the subsequent studies of Hare (1999), Spamer (1999) and Booysen (2002) who focused on five specific models. According to this guidance then, the models included in this section are those of Gimbel (1976), Harre (1982), Havlicek *et al.* (1982), Bompa (1985) and Régnier (1987).

Therefore, from the perspective of the talent identification models in this review, the basis and bulk of the discussion will be provided by du Randt and Headley (1992b) and Régnier *et al.* (1993), with further contribution from the other studies mentioned.

As an introduction to the analysis of the models in this section, the first step is to provide a description of the methods used to establish these models. Historically, there are two main methods commonly used by researchers in establishing these models, i.e.: the so-called "top down" approach and the "bottom-up" approach (Régnier *et al.,* 1993; Spamer, 1999; Booysen, 2002).

a) The "top down'" approach (also known as the devertical approach) is reliant on conventional science and accepted scientific methods of empirical data collection

(Régnier *et al.,* 1993; Hare, 1999; Spamer, 1999; Booysen, 2002). Associated with this approach are two of the more common research methods, i.e.: univariate studies (also known as single variable studies) and multivariate studies (also known as multivariable studies) (Régnier *et al.,* 1993; Spamer, 1999; Booysen, 2002).

The obvious disadvantage with univariate or a single variable studies is that only one variable is analysed when comparing talented versus less talented participants, and this approach is clearly insufficient. Multivariable studies eliminate the problems associated with single variable studies by analysing multiple variables and their impact on performance. Through multivariate analysis, the interactions between variables can be examined, as well as the relative impact of these variables on performance. This also allows for a proper statistical analysis of the variables under consideration (Régnier *et al.,* 1993; Spamer, 1999; Booysen, 2002). A common example of this kind of study is where talented and less talented sample groups are chosen and then measured according to variables such as sport-skill, physiology, morphology and others (Spamer, 1999; Booysen, 2002), with a subsequent discriminant analysis performed on the variables to determine if these do in fact distinguish between the more and less able participants (Régnier *et al.,* 1993).

Régnier *et al.* (1993) then further distinguish between unidisciplinary multivariate studies and multidisciplinary multivariate studies. Régnier's *et al.* (1993) motivation and reasoning behind multidisciplinary multivariate studies is most certainly sound; variables from only one discipline (unidisciplinary studies) are not able to explain the full variance in performance encountered in sport performance and research. Talent identification most certainly seems to be adopting a multidisciplinary, multivariate approach. This can be seen from the number of studies employing not only measures of physical and physiological variables, but also psychological variables, as chapter five shows.

In fact some of the studies (Reilly *et al.,* 2000b; Nieuwenhuis *et al.,* 2002; Falk *et al.,* 2004; Elferink-Gemser *et al.,* 2007) provided as examples in this section and throughout the preceding chapters are not only multivariate in nature, but can also be described as being of a multidisciplinary nature as well, since they include testing for variables from the discipline of psychology, alongside physical and skills variables commonly tested by the sport science disciplines.

b) The “bottom-up” (also known as the evertical approach) has as central to its approach the process of ascertaining from top achievers themselves as to the specific aspects that they feel contribute towards achieving success in sport (Régnier *et al.,* 1993; Hare, 1999; Spamer, 1999; Booysen, 2002). This can be conducted through the use of questionnaires, by interviewing these individuals, or by applying protocol analysis (see chapter five for a description of this method) (Régnier *et al.,* 1993; Hare, 1999; Spamer, 1999; Booysen, 2002).

A potential problem of this approach highlighted by Hare (1999), Spamer (1999) and Booysen (2002), and attributed to the original concerns of Régnier *et al.* (1993), is that the results obtained from such an analysis can be questioned when too many variables are considered simultaneously. It is felt that this approach may be best suited for talent development, although this approach is nevertheless considered a suitable method of determining what principles underpin success.

To follow is a review of some talent identification and detection models. At this point it is important to note that in the literature, some of the models are referred to as talent detection models. These models are however primarily referred to as talent identification models throughout the course of this section, as was the practice in the other reviews of these models. An important note is also that this section is evaluating the *original reviews* of these models. The original models themselves, as contained in this section, *were not acquired* for this study.

### 6.2.1 Gimbel (1976)

This German model approaches talent identification from three perspectives. These include; 1) trainability (able to be coached); 2) motivational aspects, and; 3) morphological and physiological considerations. This model emphasises the fact that talent consists of both environmental and genetic components and that these factors play a role in the child's development (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Durand-Bush & Salmela, 2001; Booysen, 2002).

In strengthening this view, Gimbel (1976) says that while the genetic make-up of the individual is essential to achieving excellence in sport, if the environment is not optimal for the development of the athlete, then these genetic attributes will be restrained from developing to their fullest potential (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Durand-Bush and Salmela, 2001).

Gimbel (1976) states that peak performance in sport is achieved between the ages of 18 to 20 years, after about a decade of training, and that consequently athletes with promise need to be identified between the ages of eight or nine years of age, before they undergo their growth spurt (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Durand-Bush & Salmela, 2001; Booysen, 2002).

He is of the opinion that there are three major reasons why promising youngsters previously identified as talented do not attain success. Firstly, accurate predictions are difficult due to the biological age differences between children of the same age-group. The second reason is that test batteries used for prediction purposes are not objective, valid or reliable enough. His third reason is that he feels that the role that psychology can play in the prediction of talent is not sufficiently considered (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Spamer, 1999; Durand-Bush & Salmela, 2001; Booysen, 2002).

Gimbel (1976) offers a four-stage model for talent identification as a solution to these problems. In the first stage, psychological, physical and morphological factors critical to performance are identified. In the second stage, children are tested according to these variables, with the results of these tests then used to guide or channel these children towards development programs in the sports to which they are best suited (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Booysen, 2002).

In the third stage of his model, the children's progress needs to be regularly monitored over the next 12 to 24 months, while they partake in a development program. Lastly, in stage four and at the end of the development program, a prediction is made about the child's chances of being successful in their sport (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Booysen, 2002). Depending on the results of this prediction, the child will be directed toward either a recreational program or an intensive training and development program (du Randt & Headley, 1992b; Régnier *et al.,* 1993). A major advantage of this model is that late developers are properly accommodated (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Booysen, 2002).

### 6.2.2 Harre (1982)

Also of German origin, the model of Harre (1982) assumes that the only way a judgment can be made as to whether someone possesses the attributes needed to be successful is through first exposing them to a training program (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Durand-Bush & Salmela, 2001; Booysen, 2002). Accordingly, an initial consideration of talent identification is to put large numbers of youngsters through training programs (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Durand-Bush & Salmela, 2001).

Another of Harre's (1982) assumptions was that is the athlete's social environment is an important constituent of talent identification and he therefore sees the role of social support and significant others, such as peers and family, as being of great significance in the identification and development of talent (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Booysen, 2002).

Harre (1982) goes on to define specific rules and principles for talent identification.

Rule 1: Talent identification consists of two stages. In the first stage, those youngsters exhibiting promise and general ability are identified. In the second stage, these youngsters are then classified according to the specific skills required by different types of sport (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Booysen, 2002; Wolstencroft, 2002). This classification is also carried out by means of tests that objectively measure the child's abilities (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Hare, 1999; Spamer, 1999; Booysen, 2002) and is based on the observations made regarding the child's reaction to the training program, which serves as an indication of their capacity to improve (du Randt & Headley, 1992b; Régnier *et al.,* 1993).

Rule 2: The requirements for talent identification are that it is based on the important aspects that play a role in sport performance. These aspects must be determined primarily by heredity (du Randt & Headley, 1992b; Régnier *et al.,* 1993).

Rule 3: The abilities and characteristics by which these children are evaluated need to be considered with respect to their level of biological development (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Hare, 1999; Spamer, 1999; Booysen, 2002).

Rule 4: Talent identification must further consider social and psychological variables, and not focus solely on physical variables (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Hare, 1999; Spamer, 1999; Booysen, 2002).

Therefore, the two assumptions (i.e.: the social environment and the importance of training) and the four rules combine to form the core of this model. The model consists of two main stages. A general identification of the important components of performance, such as speed, height and others is performed in the first stage (du Randt & Headley, 1992b; Régnier *et al.,* 1993).

The second stage occurs during the junior training programs and is concerned with establishing and confirming the presence of sport capacity in the children. Four indicators are used to determine the child's aptitude or talent for a sport, with the observations conducted while the child is participating in a sport-specific training program. The factors are; 1) their response to the demands of training; 2) the degree of improvement in their performance; 3) their level of performance that they achieve in the development program, and; 4) their overall stability in performance under different conditions. After the child has completed this program, a prediction is made regarding their chances of success in elite sport (du Randt & Headley, 1992b; Régnier *et al.,* 1993).

This model is regarded all round as probably one of the most conclusive talent identification models (Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Booysen, 2002), with Spamer (1999) and Booysen (2002) saying that the only drawback of this model is that it does not allow for talent identification in a team sport setting. Du Randt and Headley (1992b) and Régnier *et al.* (1993) also point out that a great strength of this model is that it underlines the relationship between talent development and identification.

### 6.2.3 Havlicek *et al.* (1982)

This (then) Czechoslovakian model is also considered to be similar to the model of Harre (1982) and makes proposals and suggestions regarding a number of important principles for talent identification. The first principle that they mention is that the purpose of talent identification is to ensure that those who possess talent for a particular sport must train specifically for that sport. The next principle they propose consists of four steps. The first step of this principle is that gifted children must be identified in physical education classes (Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Booysen, 2002). The steps after that entail the need to specialise in one "sports family" depending on the attributes and abilities of the individual, a subsequent specialisation in one sport, and then the prediction of success (Régnier *et al.,* 1993).

In their third principle they insist that while they call for specialisation in a sport, they are in fact against specialisation that is *too early*. In their fourth principle, they note their opinion that the criteria for identification need to be based on factors that have a strong, stable genetic influence. They go on to voice their view that it would be wrong to depend only on genetic factors in predicting performance (Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Booysen, 2002), since they feel that through environmental improvements, such as enhanced training and living conditions, individuals can promote further adaptations in their performance and development (Régnier *et al.,* 1993).

Principle five stresses the multidimensional nature of sport and the need for all sports sciences to participate in talent identification, principle seven states that the need for a large pool population of potential participants, while principle ten mentions that talent identification needs to occur within a larger talent development framework (Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Booysen, 2002). Another consideration of theirs, included in principle eight, is that talent identification must be performed as humanely as possible (Régnier *et al.,* 1993).

### 6.2.4 Bompa (1985)

Providing an Eastern European perspective on talent identification, Bompa (1985) lists the advantages of talent identification. These are; 1) that coaches get to instruct sports persons with more talent; 2) an increase in self confidence results if these individuals are chosen; 3) that these individuals take less time to reach top levels of performance, and; 4) that more athletes have the opportunity to reach international competition (Régnier *et al.,* 1993; Hare, 1999; Spamer, 1999; Booysen, 2002). Another advantage is that there are greater levels of homogeneity encountered in the athletes of a specific sport (Régnier *et al.,* 1993).

According to Bompa (1985), success in sport is dependent on three factors, i.e.: 1) physiological capacity; 2) morphological attributes, and; 3) motor capacity, that incorporates strength, power, endurance and perceptual-motor ability (Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Booysen, 2002; Wolstencroft, 2002). But, this model does not consider psychological variables (Régnier *et al.,* 1993; Spamer, 1999; Hare, 1999; Booysen, 2002).

In describing the model of Bompa (1985) more in-depth, du Randt and Headley (1992b) include the following description:

Bompa's (1985) model consists of a primary, a secondary and a final phase of talent identification. The primary phase, occurring during the pre-puberty phase (three to eight years of age), consists of an examination by a physician to determine the general physical development and health of the individual. In this phase, only general information about the individual is ascertained (du Randt & Headley, 1992b).

Thereafter, the most important phase of this process to select participants is performed in the secondary phase of talent identification. This phase is conducted during and after puberty and is conducted on teenagers who have already undergone training, with the techniques used in this phase aimed at assessing the functional and biometric parameters of the individual. In this phase the effects of specialised training on the individual's development and growth are considered and sport psychologists are introduced, for the first time, to compile psychological profiles of the athletes (du Randt & Headley, 1992b).

In the final phase of talent identification, the focus shifts to potential candidates for the national team. In this phase, the aspects under consideration are the athlete's; 1) physiological adaptation to competition and training; 2) potential to improve even further in performance; 3) the athlete's health, and; 4) ability to deal and cope with stress. Bompa (1985) also maintains that there are ideal models in each sport, and that by adhering to this notion coaches and sport scientists can compare individual athlete's results with the idea model for that specific sport, with this aiding in the process of selection (du Randt and Headley, 1992b).

In their original review, Régnier *et al.* (1993) make mention of some problems associated with these models. These problems include the environment/heredity interplay, the ability of individuals to compensate their weaknesses in one area with strengths in another, talent surveillance versus detection or identification, and longitudinal studies. These will be briefly addressed with some aspects from earlier in this study provided within this discussion.

1) The issue regarding the interaction or interplay between the environment and heredity is regarded as being very important to talent identification research (Régnier *et al.,* 1993; Spamer, 1999; Booysen, 2002).

In chapter four, this specific issue was addressed at length. The developmental and environmental impact on talent development was evaluated, as was the nature versus nurture debate. This review consisted of providing heritability estimates that provide an overview of the impact of genetics on performance. Rebuttals were provided that presented the nurturist perspective on talent, and this incorporated the influence of practice and significant others on talent development.

The heritability estimates provided by Klissouras (2001), Hohmann and Seidel (2003), Klissouras *et al.* (2007) and others showed broad ranges of heritability for a number of physical performance factors and variables. Further, these studies emphasised the influence of development and the environment on the development of talent and excellence, with others (Simonton, 1999, 2001, 2005, 2006, 2007; Van Rossum & Gagné, 2005; Morgan & Giaccobi, 2006; Starkes, 2007) adopting a specific centrist or interactionist approach that also acknowledges the role of the environment, social support, genetics and others on the development of talent. This review also incorporated the most prominent (Bloom, 1985; Ericsson *et al.,* 1993; Côté, 1999) and recent (Button & Abbott, 2007; Côté *et al.,* 2007) models of talent and expertise development.

If a balanced perspective is to be adopted from the literature presented throughout the course of this study, then the general feeling is that genetics do play a role in talent, but that the development of this genetic endowment depends on adequate and meaningful practice, sufficient social support and psychological factors such as motivation, commitment and others. The overall views of Régnier *et al.* (1993) were also that there is an interaction between genes and the environment in the development of talent.

2) Another issue that demands attention and that is noted by Régnier *et al.* (1993:300) is what they refer to as *"The Compensation Phenomenon."* This concept assumes that success in sport is dependent on different attributes, skills, variables and capacities, and that these are found in individuals in different combinations. As an example of this, short individuals tend to perform better at gymnastics, yet there are gymnasts who are taller than the norm who still do well. It is therefore difficult to make predictions of success based on certain variables or attributes that a person may possess (Régnier *et al.,* 1993; Spamer, 1999; Durand-Bush & Salmela, 2001; Booysen, 2002). This position is further emphasised in that both Régnier *et al.* (1993:300) and Durand-Bush and Salmela (2001:272) cite the findings of Bartmus *et al.* (1987) that *"…no uniform tennis performance ability exists: Deficiencies in one area of performance can be compensated for by a high level in others."*

But, while this compensation phenomenon does promote a certain amount of caution, it is also clear that different sports types have specific requirements for success to be attained. Régnier and Salmela (1987) in Spamer (1999) and Salmela and Regnier (1983) in Booysen proved that gymnasts younger than twelve years of age needed power/strength and speed for successful participation. For their part, Régnier *et al.* (1993) and Durand-Bush and Salmela (2001) also refer to the findings of Régnier and Salmela (1987) who hold that these factors (power, speed, strength) sufficiently predicted performance, accounting for 100% of the performance variance at the age of twelve, but, that at the age of twenty, other variables such as anxiety, spatial orientation and perceptual awareness were found to differentiate between gymnasts at the highest level of participation.

Régnier *et al.* (1993) and Durand-Bush and Salmela (2001) attributed these findings to the proper implementation of a task analysis that considers both physical as well as mental (psychological) attributes as contributors to performance, implying both a multidimensional and multivariate approach to talent identification. What these examples also emphasise is that while there might be specific performance determinants for successful participation in sport at a certain age, these determinants do change as time progresses, especially throughout adolescence.

3) Another consideration raised is that of talent surveillance. This concept relates to the feeling within research that the focus should shift from talent detection and identification to talent guidance and development (Régnier *et al.,* 1993; Durand-Bush & Salmela, 2001), with Spamer (1999) and Booysen (2002) interpreting this notion as a move toward combining talent identification and development.

Later in this chapter, it is shown that there are modern calls for a shift in emphasis toward talent development; in fact, some feel that development should be the overriding factor. The concession is made by this study that while talent identification and development contribute towards the success of each other, that development should probably be the overarching concern, with intermittent talent identification fulfilling a facilitative role in the process. These sentiments are in agreement with those of Régnier *et al.* (1993) and others later in this chapter. And as can be seen later in this chapter, the processes of identification (selection) and development operate hand-in-hand in the SANZAR nations, including South Africa.

4) There is a recommendation regarding longitudinal studies. Longitudinal talent identification studies are required if objective deductions are to be made. In these studies, the variables need to be regularly monitored over a period of three to ten years. The variables possessing a low hereditary component tend to be

unstable during these longitudinal studies, since environmental factors can influence these variables more readily (Régnier *et al.,* 1993; Spamer, 1999; Booysen, 2002).

There are brilliant examples of longitudinal studies that have been undertaken in talent identification and development, such as those of Pienaar and Spamer (1998), Hare (1999), Falk *et al.* (2004), Vaeyens *et al.* (2006), Elferink-Gemser *et al.* (2007) and Lidor *et al.* (2007). Plotz and Spamer (2006) also make mention of Spamer and Hare (2001) in this regard. And, still other notable studies, such as the studies of Van Gent (2003), Van Gent and Spamer (2005), have established prediction functions for different age-groups throughout the adolescent period. In addition to being a longitudinal study spanning five years, Vaeyens *et al.* (2006) also determined the specific characteristics and variables that discriminate between players at different age-groups throughout adolescence.

Before presenting the model of Régnier (1987), the principles that should guide talent identification models, as proposed by Régnier *et al.* (1993), are briefly listed. These are that; 1) talent identification must provide a long term prediction of success; 2) the determinants of performance need to have a strong hereditary influence, and; 3) talent detection and identification needs to occur within the larger framework of talent development (du Randt & Headley, 1992b; Régnier *et al.,* 1993).

Other principles are that; 4) the demands of different sports vary and therefore, the determinants and criteria for success in each sport need to be established; 5) a multidisciplinary approach must be adopted in talent identification, and; 6) performance determinants and requirements can improve with training and practice, and also change with age (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Spamer, 1999; Booysen, 2002)

Régnier (1987) established these principles and designed his model to address the short comings that he had identified in the preceding models of talent identification (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Hare, 1999; Spamer, 1999; Booysen, 2002).

### 6.2.5 Conceptual model for talent identification

#### 6.2.5.1 Régnier (1987)

The model of Régnier (1987) was developed for his doctoral dissertation. He based his model on orthodox/conventional science and incorporated the guiding principles of talent identification listed just prior. It has a broad, multidisciplinary and multivariate design, and is of great value to sport science and all sports disciplines (Régnier *et al.,* 1993). This model also provides a broad talent identification framework that can be applied to any type of sport (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Hare, 1999; Durand-Bush & Salmela, 2001). As a consequence, the model of Régnier (1987) has been used in sports such as gymnastics and baseball (Regnier *et al.,* 1993; Hare, 1999; Spamer, 1999; Durand-Bush & Salmela, 2001; Booysen 2002). An added benefit of this model is that it can successfully be applied to team sports, as noted by Hare (1999), Spamer (1999) and Booysen (2002) who refer to the studies done by Pienaar and Spamer (1997; 1998) on rugby.

There are two main phases to this model. The first phase consists of a task analysis to determine the performance criteria or sport-specific requirements for success. The second phase consists of another task analysis to analyse the determinants of performance (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Hare, 1999; Spamer, 1999; Booysen, 2002).

Each of these phases will now be briefly evaluated:

##### *6.2.5.1.1 Identification of sport-specific requirements*

For talent identification to be effective and reliable, it is imperative that all the possible criteria and requirements that play a role in effective performance be precisely determined. The principle behind this is that if performance is to be accurately predicted, it needs to be accurately identified and measured. The assumption is therefore that sports participants will be successful if they meet and comply with these sport-specific criteria and requirements (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Hare, 1999; Booysen, 2002).

While at face value this approach may seem obvious, this is certainly not always the case. In certain types of single dimensional sports, such as running, swimming, discus or pole vault, where only one objective needs to be met and where the prediction function is one dimensional in terms of height, distance or time, then simplicity is most certainly the case (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Hare, 1999; Booysen 2002).

In multidimensional sports, however, the situation is more complicated, since there are several actions that need to be executed simultaneously to facilitate effective performance or success in this task. In cases such as these, a thorough task analysis of the requirements of this sport and its constituent elements needs to be conducted. In certain cases this can be done by means of observation or through determining the opinion of sport participants themselves. The two main methods that are used for this purpose are the top down (devertical) approach and the bottom up (evertical) approach that that were discussed earlier in this chapter (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Hare, 1999; Booysen 2002).

As highlighted previously, the devertical method makes use of conventional and orthodox scientific methods. This task analysis is conducted from the following two perspectives; 1) how the sport is currently practiced and played, or; 2) that the most effective ways of achieving success in sport are as yet undiscovered and need to be determined by means of conceptual models. The evertical approach, on the other hand, is aimed at ascertaining from top performers what the aspects are that cause or contribute to top performance and excellence. This is done according to the methods previously identified for this evertical approach (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Hare, 1999; Booysen, 2002).

In a possible solution as to the recommended approach to follow, Régnier *et al.* (1993:304) say that *"The underlying assumptions concerning the actual state of knowledge in a given sport discipline must be considered before developing a detection instrument."* In other words, an analysis of how the sport is currently played is probably the best option to be adopted. But, the knowledge of top performers can certainly be considered valuable in this regard.

After the essential sport-specific requirements or criteria have been determined and the objectives of these requirements and criteria properly defined, then the identification of specific success or performance determinants can be conducted (du Randt & Headley, 1992b; Régnier *et al.,* 1993).

This second phase is referred to as the identification of the determinants of performance.

*6.2.5.1.2 Identification of determinants of performance*

This task analysis is conducted to determine the essential underlying factors or variables that contribute towards achieving success in a sport. Psychological, morphological, environmental and perceptual-motor variables are considered to be the determinants that most likely contribute toward performance. In this task analysis, experts are consulted and the existing literature in the field or sport concerned is reviewed. To increase the chances of realising talent, it is advised that the selected determinants (also referred to as predictors of talent) have a strong and stable genetic influence (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Hare, 1999; Booysen, 2002).

The model of Régnier (1987) also relies on the so-called "sliding populations" principle (du Randt, 1992b; Régnier *et al.,* 1993; Hare, 1999; Spamer, 1999;

Booysen, 2002). While this concept essentially falls outside the scope of this particular study, a short description will be provided for the sake of clarity.

The sliding populations approach can be used as an alternative to longitudinal studies. Whereas longitudinal studies monitor the same group or population of individuals from pre-pubertal levels through to adulthood, the sliding population approach is the process of testing various age-groups concurrently. A unique test battery is developed for each age group and this battery is designed to identify those individuals from the "pool population" of one age-group that have the potential to reach the "target (elite) population" of the next age-group. It is important during the selection of the pool population to involve as many children as possible, so that those who have potential are not excluded. Another important principle to this approach is that the pool population for a specific age group should not incorporate those youngsters who are used as the target population for the preceding age group's pool population (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Hare, 1999; Spamer, 1999; Booysen 2002).

As a way of preventing those late developers from missing out altogether, it is recommended that those individuals who just missed selection to the target population of the preceding age group should be incorporated into the current age group's pool population. This is done to account of the rapid changes that take place in puberty due to physical growth and development, with these changes having a serious impact on the development of capacities and attributes of youngsters, who can often experience impressive improvements in these capacities and attributes over a short space of time. But, over time it is found that the overall population of successful participants becomes smaller and more similar in terms of their psychological attributes and their ability to acquire new skills (du Randt & Headley, 1992b; Régnier *et al.,* 1993).

Csikszentmihalyi and Robinson (1986) in Régnier *et al.* (1993) say that in the development of talent and excellence, a drop out phenomenon is often encountered, with this also found in Régnier's (1987) model. They go on to say that those individuals who eventually drop out usually undergo certain major life changes, such as a crisis of identity and others (du Randt & Headley, 1992b; Régnier *et al.,* 1993; Hare, 1999; Spamer, 1999; Booysen, 2002). Jerome *et al.* (1987), also in Régnier *et al.* (1993), confirm these findings of Csikszentmihalyi and Robinson (1986), but in their study they found that those who eventually attain success are characterised by dependence, obedience and submissiveness (Régnier *et al.,* 1993; Hare, 1999; Spamer, 1999; Booysen, 2002).

To conclude this discussion, it can be said that Régnier's (1987) model provides specific guidelines and principles by which talent identification can be conducted. Some of the positive aspects inherent to this model are; 1) the importance of a multidisciplinary approach to talent identification is underscored; 2) through establishing prediction functions for different age groups, the effects of development, maturation and age are accounted for; 3) each step that needs to be taken in the process is comprehensively described; 4) the interactions between the sport-specific requirements and the associated psychological, environmental, morphological and physiological factors are analysed and described through a thorough statistical process, and; 5) this model has been applied to team sport settings (Hare, 1999; Spamer, 1999; Booysen, 2002).

Therefore, due to the advantages of this model of Régnier (1987), it can quite rightly be described as an appropriate method for thorough and rigorous scientific and empirical research and enquiry into talent identification.

### 6.2.6 Talent identification in South Africa

The readmission of South Africa into international sport provided the major role players in South African sport with new insights as to the requirements of international sport participation (Hare, 1999; Spamer, 1999; Booysen, 2002). At the time of this readmission, du Randt and Headley (1992a:1) said *"…the international* *sporting doors are gradually opening allowing South Africa re-admittance to international competition. All these changes bring about exciting challenges."*

Since then, the doors to international sport have swung wide open and remarkable achievements have been made. South Africa became the CAF African Champions in soccer in 1996, IRB World Champions in rugby in 1995 and 2007, have a handful of Olympic and Commonwealth Games gold, silver and bronze medals and have experienced great, albeit often very rocky progress in the world of sport. Furthermore, South Africa is hosting the 2010 World Cup.

When considering the past decade and a half, the exciting challenges referred to by du Randt and Headley (1992a) remain, and have arguable grown. And, since our readmission roughly coincided with the sweeping political changes occurring in this country, it stands to reason that an accompanying consideration in sport is that of politics. The pre-democratic history of South Africa is common knowledge. Reparations are demanded, as is equality, and rightfully so. The question remains; how are these concessions made while maintaining the proud record of South African sport. The answer may very well be proper, sustained and all-encompassing talent identification and development. And in fact, this was realised by the ANC as far back as 1994, who according to Spamer and De la Port (2006) placed great emphasis on sport development in South Africa.

Due to this recent re-exposure to international sport, talent identification in South Africa can therefore also be considered to be a recent pursuit, although studies on this issue predate readmission by almost a decade. The earliest studies on talent identification in this country date to the early and middle 1980's. Hare (1999), Spamer (1999) and Booysen (2002) make mention of the studies of Daehne (1983) in athletics and Pienaar (1987) in gymnastics.

It is however the work of du Randt (1992) that is widely regarded as having the greatest impact on talent identification in this country. Du Randt (1992) (and colleagues) made an important contribution to research in South Africa in her study concerning talent identification worldwide. In this study, as mentioned earlier, she described the respective talent identification models from a historical perspective, as well as the talent identification and development practices of many countries. Her study examined the contributions of physical, anthropometrical and psychosocial aspects to talent and the identification thereof. She also made guidelines and recommendations for talent identification and development best practice from a uniquely South African perspective (Spamer, 1999; Booysen, 2002).

But, are the findings of du Randt (1992) with regards to the guidelines and recommendations provided still valid, fifteen years later? In the relevant section, compiled by du Randt and Headley (1992d), some of the most prominent issues are:

1) Talent development programs need to adopt an initial generic, all-encompassing approach, followed by a more sport-specific emphasis. These development programs also need to precede and operate concurrently with talent identification initiatives (du Randt & Headley, 1992d).

2) A distinct multidisciplinary focus and approach is required. Furthermore, the test batteries utilised for the initial selection of talented individuals should be scientifically sound, easily administered, and should also be simple and practical (du Randt & Headley, 1992d; Hare, 1999; Spamer, 1999; Booysen, 2002).

3) It is preferable that as large a group as possible be exposed to the talent identification processes. The norms from talent identification are only valid for between two to four years, and therefore, to remain current and relevant, talent identification needs to be an ongoing concern (du Randt & Headley, 1992d; Hare, 1999; Spamer, 1999; Booysen, 2002).

4) General fitness development and testing at schools are to be encouraged at national and regional level (du Randt & Headley, 1992d; Hare, 1999; Spamer, 1999;

Booysen, 2002). There is also a recommendation to adopt an awards based system to reward the achievement of fitness standards (du Randt & Headley, 1992d; Hare, 1999)

5) Coaches should be trained in development and sport national bodies included as part of the talent identification process (du Randt & Headley, 1992d; Hare, 1999; Spamer, 1999; Booysen, 2002). Furthermore, talent identification should not render coaches redundant, but should assist them in their task, with large numbers of qualified coaches ideally assigned to talent development structures (du Randt & Headley, 1992d).

6) Biological age needs to be considered in talent identification (this issue was raised in chapter four and will be reviewed again later in this chapter) and the late maturer needs to be accommodated (du Randt & Headley, 1992d; Hare, 1999; Spamer, 1999; Booysen, 2002).

Other pertinent guidelines for sport scientists originally provided by du Randt and Headley (1992d), and subsequently noted by Hare (1999), Spamer (1999) and Booysen (2002) are that:

7) Population specific norms for South Africa need to be established; 8) the effects of growth and development on inherited traits must be analysed for norm establishment purposes; 9) every sport needs to establish a specific model of talent identification and development, and; 10) quasi-longitudinal studies need to be conducted utilising the sliding population principle of Régnier (1987).

From an objective perspective, it is abundantly clear that a large proportion of these guidelines still stand, and some even more so now than before. Some of the further findings of du Randt (1992), in the sub-section of du Randt and Headley (1992c), will later be contrasted with findings of recent studies and, therein the impact of du Randt (1992) can be fully gauged; her work’s legacy and value is certainly enduring.

But, since this tone setting study, a number of subsequent and highly relevant studies have been published.

This study acknowledges the massive contributions of Pienaar and Spamer (1996a, 1996b, 1998), Pienaar *et al.* (1998, 2000), Hare (1999) and Nieuwenhuis *et al.* (2002) toward expanding the field of talent identification in South Africa. Hare (1999), Spamer (1999), Booysen (2002) and Nieuwenhuis *et al.* (2002) in turn acknowledge the work of Pienaar and Spamer (1995; 1997), Pretorius (1996), Hare (1997), Van der Merwe (1997), Badenhorst (1998) and Nieuwenhuis (1999) as studies that have added value to talent identification in this country. This study therefore gratefully acknowledges these researchers and their findings as well.

In conclusion of this section on talent identification in South Africa, a brief analysis of a select sample of these studies is included hereafter. Only those studies consistently cited in this current study were chosen for this analysis:

1) Probably the most prominent talent identification specialists in South Africa are Professors Anita Pienaar and Emmanuel (Manie) Spamer from the North-West University in Potchefstroom. The studies of Pienaar and Spamer (1996a, 1996b) and Pienaar *et al.* (1998, 2000) have made valuable and ground breaking contributions to talent identification in rugby.

As noted in chapter one, Reilly *et al.* (2000b) and Reilly and Gilbourne (2003) refer to the work of Pienaar, Spamer and colleagues, and in particular to their pioneering use of multivariate approaches in identifying talent in team sports such as rugby that was originally performed by these two researchers in conjunction with Steyn in 1998. Other studies, such as Abbott and Collins (2002), Pearson *et al.* (2006), Vaeyens *et al.* (2006), Elferink-Gemser *et al.* (2007) and Vaeyens *et al.* (submitted) are those who have cited, or acknowledged the work of these researchers.

Furthermore, the work of Spamer and Coetzee (2002) on the variables that distinguish between talented and less talented participants has also received the attention of Lidor *et al.* (2005; 2007). And, Professor Spamer was also the second author in the study of Nieuwenhuis *et al.* (2002) that will be discussed shortly.

2) Hare (1997) constructed a prediction function for 16-year old rugby players from psychological, physical and motor, game-specific skills and anthropometric variables (Hare, 1999; Spamer, 1999; Booysen, 2002). Another notable work is that of Hare (1999:iii), a significant longitudinal study with findings that *"…growth and development had a significant influence on the performance of talented rugby players over a period of six years."*

3) Nieuwenhuis *et al.* (2002) has been cited in the studies of Abbott and Collins (2002; 2004), Elferink-Gemser *et al.* (2006; 2007) and Vaeyens *et al.* (submitted). In this study, a prediction function for fourteen to fifteen year old female hockey players was established.

4) In many regards talent identification remains an unexplored field in South Africa. This is gradually changing however, and in the last number of years, definite progress can be seen in this field. By and large, the focus of these older and more recent studies (Pienaar *et al.,* 2000; Krüger *et al.,* 2001; Spamer & Winsley, 2003a; 2003b; Van Gent, 2003; Van Gent & Spamer, 2005; Plotz and Spamer, 2006; Spamer & De la Port, 2006) has been on rugby.

Interestingly, the studies of Plotz and Spamer (2006) and Spamer and Winsley (2003b) focussed on elite U/18 South African rugby players in comparison to elite U/18 English rugby players, with the findings in both studies largely favouring the South African players. But, talent identification studies on other sports in South Africa can be found, such as those on swimming (Myburgh, 1998; Coetzee *et al.,* 2001), hockey (Nieuwenhuis *et al.,* 2002), and even kayaking (Olivier & Coetsee, 2002).

So, while it seems as if the research output in this field is demonstrating an obvious upward track, it is perhaps still not where it could be, or where it should be. This prominent increase in growth is nevertheless encouraging and bodes well for the future of sport in South Africa.

## 6.3 ORIENTATION OF THIS STUDY

This study is heavily informed upon by the preceding studies discussed in this section (Pienaar & Spamer, 1996a, 1996b, 1998; Pienaar *et al.,* 1998, 2000; Hare, 1999; Krüger *et al.,* 2001; Booysen, 2002; Spamer and Winsley, 2003a, 2003b; Van Gent, 2003; Van Gent & Spamer, 2005; Plotz & Spamer, 2006; Spamer & De la Port, 2006). The broad testing protocols that have been tried and tested over the years have formed the basis of this study, although many of the actual tests used in this study differ from the tests in these afore-mentioned studies. The multi-variate categories of testing, i.e.: anthropometrical, physical-motor and sport-specific skills have remained the same, although an extra sport vision section has been included. Furthermore, testing has taken place within broad positional categories that were determined prior to testing, i.e.: tight forwards, loose-forwards and backs, similar to Van Gent (2003) and Van Gent and Spamer (2005).

The sample groups in this study consisted entirely of elite rugby players from the 2005 Blue Bulls Vodacom Cup Squad consisting almost entirely of the U/21 Currie Cup rugby players, the 2005 South African U/21 rugby squad and the 2005 TUKS Rugby Academy at the University of Pretoria.

The major difference with regards to the choice of the sample groups of this study as opposed to those mentioned before is as a result of the methodology used in the respective studies. No statistical discrimination between more or less successful groups or players was performed in this study, since the sole purpose and main aim of this study was to establish norms and performance scales for future reference. The specific study of Krüger *et al.* (2001), in which physiological and performance scales were established for junior rugby players, served as motivation and guidance in this regard.

With regards to the age-groups selected; it is the intention of this study that the test protocol that was developed, as well as the norms and standards that have been established, can be used for future reference as both talent identification tool as well as a tool used purely for selection purposes to elite teams and squads. A number of the individuals included in this study have gone on to play provincial Currie Cup rugby, regional Super 12/14 rugby, the emerging Springboks, and one was even called up to Springbok duty. Furthermore, two of the squads used in the sample for this study achieved great success; one went on to become the IRB U/21 World Champions (SA U/21) in 2005 whereas the other went on to become the National Junior Currie Cup Champions and semi-finalists of the Vodacom Cup (Blue Bulls), also in 2005. These results thereby further confirm the elite status of this sample group.

Therefore, to summarise, this study and its findings can be used as a talent identification tool, but possibly lends itself more toward being utilised as a selection tool to determine admission to elite junior rugby squads or initial admission to senior elite rugby squads.

## 6.4 CURRENT DAY PERSPECTIVES ON TALENT IDENTIFICATION

The success of current talent identification practices has been emphasised throughout this study. The focus on physical/physiological, anthropometrical and skills perspectives in talent identification and assessment have been proven to be highly successful (Aitken & Jenkins, 1998; Hoare, 1998; Pienaar *et al.,* 1998; Nieuwenhuis *et al.,* 2002; Spamer & Winsley, 2003b; Falk *et al.,* 2004; Van Rossum & Gagné, 2005; Gabbett *et al.,* in press). Prediction accuracies in excess of 60% (Falk *et al.,* 2004), 70% (Gabbett *et al.,* in press), 80% (Bompa, 1985 in Aitken & Jenkins, 1998; Pienaar *et al.,* 1998) and 90% (Nieuwenhuis *et al.,* 2002) have been achieved and/or noted.

Furthermore, the specific issue of an increased focus on sport-specific skills in testing has also been repeatedly underscored. This concept is far from a new consideration and was highlighted as far back as 1992 in the pioneering studies of du Randt (1992) and thereafter Pienaar and Spamer (1995) in Pienaar and Spamer (1998). And, included in the testing protocols of most of the talent identification studies on rugby (Pienaar & Spamer, 1996a, 1996b, 1998, Pienaar *et al.,* 1998, 2000; Hare, 1999; Booysen, 2002; Spamer and Winsley, 2003a, 2003b; Van Gent, 2003; Van Gent & Spamer, 2005; Plotz and Spamer, 2006; Spamer & De la Port, 2006), swimming (Coetzee *et al.,* 2001), hockey (Nieuwenhuis *et al.,* 2002; Elferink-Gemser *et al.,* 2007), water-polo (Falk *et al.,* 2004), volleyball (Gabbett & Georgieff, 2006; Gabbett *et al.,* in press) and soccer (Vaeyens *et al.,* 2006), sport-specific skill evaluations can be found. So, the trends in this regard are clear for all to see.

Admittedly, though, current talent identification approaches have their detractors. Issues with current (and older) talent identification approaches and designs continue to be raised in the literature regarding the short-comings and problems with current talent identification designs. Therefore, this sub-section discusses specific problems with talent identification that continue to be raised in the literature, followed by suggested solutions in this self-same literature. Thereafter, the interesting (some would say frightening) concept of genetic testing as an alternative or supplementary practice to talent identification is briefly considered.

### 6.4.1 Modern day perspectives on talent identification and development

Most of the problems associated with current talent identification practices are not new and have been the topic of discussion on numerous occasions. This is evidenced by the literature that can be found on this topic. A lot of this literature has been incorporated in this very study. Recently, however, two noteworthy documents have come to light that deal pertinently with these traditional and current issues and short-comings in talent identification. These documents also further provide proposed solutions to address these shortcomings.

The first document in question is an invited review of the current trends and models in talent identification and development. This document was recently submitted to the journal "Sports Medicine," wherein the authors Roel Vaeyens, Matthieu Lenoir, A. Mark Williams and Renaat M. Philippaerts present a brilliant and relevant summary and critique of current day talent identification and development practices. They then also provide certain recommendations for future research in this field. This specific article has also been used extensively throughout the course of this thesis.

Similarly, in a report for "**sport**scotland" completed by The University of Edinburgh, the authors Angela Abbott, Dave Collins, Katie Sowerby and Russell Martindale also focus on the limitations of current talent identification approaches, while presenting the findings of an extensive talent development scheme called Developing the Potential of Young People, or DPYPS. This DPYPS approach will then be used to assist in the development of a Long Term Player Development (LTPD) model that will be used by most sport governing bodies. This document has also been incorporated within the preceding chapters of this study.

The format of this discussion will therefore centre on the broad-spectrum discussions and arguments presented by these two documents. But, since a number of their perspectives and ideas have already been considered and incorporated elsewhere in this study, only their broad stroke concepts, critiques and guidelines will be discussed. Pertinent to note, however, that the literature reviews that these studies conducted include many of the other studies and literature that have also been included in this study, and so, these other literature resources (as well as some new resources) will be incorporated only where necessary. As an added exercise, the problems highlighted by du Randt and Headley (1992c) will be referred to in an effort to contrast the progression of these views over the last decade and a half.

The review of Vaeyens *et al.* (submitted) identifies four main problems associated with current talent identification designs applied to adolescent, age-specific samples that incorporate anthropometric, physiological, physical and technical variables in their performance predictions.

#### 6.4.1.1 Problems

1) Unstable physical characteristics in childhood and adolescence

The first problem with talent identification as noted by Vaeyens *et al.* (submitted) is the unstable development of physical characteristics throughout childhood and adolescence. Studies of a cross-sectional design often make the assumption that the characteristics required for achieving success in adult performance and achievement can be used to identify talent in children and adolescents (Morris, 2000; Vaeyens *et al.,* submitted). But, it has been shown that certain beneficial physical characteristics aren't always retained as children and adolescents mature (Ackland & Bloomfield, 1996; Vaeyens *et al.,* submitted).

Abbott *et al.* (2007) are found to agree with the preceding sentiments in this regard; they are of the opinion that while it is possible that the current performance of a young athlete may be helpful in identifying the potential for this athlete to develop into a top performer in the future, it is by no means a concrete guarantee of future success.

Another aspect to be considered is that many characteristics required for success in adult sport participation may not even visible until late adolescence (Vaeyens *et al.,* submitted). In saying this, Vaeyens *et al.* (submitted) refer specifically to the work of Bloom (1985) and Simonton (1999). While the findings of Bloom (1985) were discussed in chapter four, a brief elaboration of Simonton (1999) is merited at this time. Simonton (1999), and his subsequent work (Simonton, 2001; 2005; 2006), propose an emergenic/epigenetic nature of talent, i.e.: that one can inherit traits or components that contribute to the development of talent, but, that these traits develop or come to the fore at their own genetically predetermined rate.

According to epigenesis, talent is not always even apparent at young ages, and, talent can even be lost as these traits further develop or decline. But, a significant factor of the epigenetic development is the influence of the environment. And environmental influence, along with certain individual aspects, is something that Vaeyens *et al.* (submitted) and others (Ericsson *et al.,* 1993; Gould *et al.,* 2002) say is needed to develop talent and expertise, although by now it is obvious that Ericsson *et al.* (1993) and other studies of the first author for the most part reject a genetic explanation of talent in favour of practice and training.

Therefore, the unstable character of physical variables in childhood and adolescence impacts heavily upon talent identification.

2) Maturation

The second problem mentioned by Vaeyens *et al.* (submitted) is the problem of maturity related development, with this issue impacting on talent identification and development. The advantage that early maturers enjoy in performance characteristics such as strength, aerobic power and motor skill (Malina *et al.,* 2004b; 2007; Vaeyens *et al.,* 2005b; Vaeyens *et al.,* submitted) is evident, along with the need to compare children and adolescents to norms based on biological age as opposed to chronological age (Hahn & Gross, 1990). The relative disadvantage that late maturers are subjected to if chronological-based norms are used for comparison is further emphasised by Vaeyens *et al.* (submitted). It has been shown that early maturing individuals are usually classified as talented (Williams & Reilly, 2000b; Sherar *et al.,* 2007) and that later maturing individuals are consequently overlooked. Early maturation is also a problem that was emphasised in 1992 in the study of du Randt and Headley (1992c), indicating that this issue of early maturation is certainly not a new consideration.

The relative-age effect and its impact on elite representation in sport (Musch & Grondin, 2001; Vaeyens *et al.,* 2005a; Côté *et al.,* 2007; Medic *et al.,* in press) has been proven and is said by Vaeyens *et al.* (submitted) to have an impact on talent identification and further development. The views of Vaeyens *et al.* (submitted) and others on maturation and related factors were represented extensively in chapter four, with every aspect raised under this point described rather extensively. Therefore, any further elaboration can be found in that chapter.

One aspect of maturation not fully considered is the level of development of the mental abilities of the individual. Some mental abilities, like the ability to focus, can take years to develop (Gould *et al.,* 2002; Abbott *et al.,* 2007) and the current lack of these attributes may contribute toward athletes with talent potential to be overlooked. Maturation can consequently be seen as presenting a problem to talent identification.

3) Talent as a dynamic concept

The third aspect under consideration is that of talent being a dynamic concept. Often, predictions of future performance are based on variables that are (mistakenly) regarded as static and unchanging in nature. These predictions do not take the unstable, ever-changing and evolving nature of these variables and attributes into account and this makes for inaccurate long-term predictions (Régnier *et al.,* 1993; Abbot & Collins, 2004; Vaeyens *et al.,* submitted).

Training, development and growth often have a significant impact on the physical variables of performance. This impact can cause an unpredictable development of these variables and attributes, and this makes the predictions of future performance based on current achievement a risky prospect, especially when these predictions are made before puberty (Abbott & Collins, 2002; Vaeyens *et al.,* 2006; Vaeyens *et al.,* submitted). Vaeyens *et al.* (submitted) also say that the practice histories of the individuals also have an effect on these variables of performance.

In illustrating their point, Vaeyens *et al.* (submitted) refer to research (Pienaar & Spamer, 1998; Nieuwenhuis *et al.,* 2002) that has shown that the kinanthropometrical variables that discriminate at ten years of age are not as discriminating in the later years of adolescence. Of course, other studies (Pienaar & Spamer, 1996a; Abbott & Collins, 2002) can also be added to those that have encountered the same phenomenon or made mention thereof. The opinion of Vaeyens *et al.* (submitted), and others in this regard have also been mentioned in earlier chapters.

Abbott *et al.* (2007), for their part concur with most of these sentiments and go further by saying that due to the changing and evolving nature of talent, the chances of identifying talented athletes and sportspersons increases over time. This is because the closer these performance variables and attributes get to their mature state, the easier it is to judge as to whether they are in fact present within the individual. A faulty or incorrect assumption as to the stability of talent in childhood and adolescence is certainly a major complicating factor for effective talent identification.

4) Use of limited variables

The final problem highlighted by these researchers is that most talent identification considers only limited variables in their designs. Innate capacity and talent consists of many components (Simonton, 1999; Abbott & Collins, 2004; Vaeyens *et al.,* submitted). Yet, one still finds that most studies have adopted a single-dimensional approach or a design that includes only physical, physiological and anthropometric variables. Vaeyens *et al.* (submitted) refer to a host of studies as examples of this approach, with the studies of Aitken and Jenkins (1998) and Gabbett (2002a) the ones that apply to this study.

It must be noted at this juncture, though, that du Randt and Headley (1992b) do mention the fact that certain variables are more applicable to certain age phases than others, while other variables in turn become more important at later ages. Du Randt and Headley (1992b) therefore suggest that testing criteria are to be designed to cater for these age-related differences in performance variables. So, while testing limited variables in talent identification on a single-dimensional basis is certainly a problem on the whole, it could be implied by du Randt and Headley's (1992b) sentiments that designing testing criteria to address limited variables may in fact be acceptable when age related performance variables and criteria are considered.

Vaeyens *et al.* (submitted) then go on to make mention of the compensation phenomenon whereby those who may be lacking in certain areas still make up for it in other areas to perform optimally at tasks and in sports (Williams & Ericsson, 2005; Vaeyens *et al.,* submitted). Earlier, it was Regnier *et al.* (1993) who also noted this finding. Others who mention this specific issue are Tranckle and Cushion (2006). The problem with this phenomenon is that some individuals who may be highly able in a sport might still not be selected, because in some of the variables that are measured, they may not have the requisite score, with the opposite also being true (Vaeyens *et al.,* submitted).

A final consideration is that psychological variables are often not considered in talent identification (Morris, 2000; Abbott & Collins, 2004; Vaeyens *et al.,* submitted). Since individuals become more similar in terms of physiology and physical ability, it is postulated by some that psychological variables can be viewed as the *only significant predictors* of success in sport when compared to other variables (Vaeyens *et al.* submitted). Chapter five made the case for the inclusion of psychological variables in talent identification protocols and batteries.

As can be seen from this problem analysis, Vaeyens *et al.* (submitted) and Abbott *et al.* (2007) have provided an in-depth analysis of the inherent problems associated with current talent identification and development models. From the comparison provided with du Randt and Headley (1992c), it is clear that some of these problems are not new, and that solutions to these issues are still being sought.

What follows now are the recommendations of Vaeyens *et al.* (submitted) for research that could provide possible solutions to these problems. These recommendations come in response to the criticisms that emanate from literature and the research field.

#### 6.4.1.2 Solutions and recommendations

1) Emphasis on development over the long-term

The first recommendation from Vaeyens *et al.* (submitted) concerns development. There are growing calls from many corners for the emphasis to shift from talent identification to the provision of development opportunities for as many youngsters as possible (Morris, 2000; Abbott & Collins, 2002, 2004; Martindale *et al.,* 2005; Vaeyens *et al.* submitted). In this way, those with promise can receive the fullest opportunity (training, practice and support) to develop to their fullest potential, with a conducive environment playing the major facilitating role in this process (Morris, 2000; Abbott & Collins, 2004; Vaeyens *et al.,* submitted).

The authors once again cite the prominent work of Bloom (1985) who advocated the support of parents and coaches in the development of talent, and Ericsson *et al.* (1993) who proposed their Theory of Deliberate Practice as being the solution to develop expertise and ability. These and others (Côté, 1999; Button & Abbott, 2007; Côté *et al.,* 2007) were analysed in chapter four. Vaeyens *et al.* (submitted) in fact do make recommendations regarding the model of Côté *et al.* (2007) (for further elaboration see chapter four) that provides for deliberate play and deliberate practice as the individual advances in their career, and these recommendations receive a resounding endorsement by this study.

A specific, real-world talent development program that is mentioned by Vaeyens *et al.* (submitted) is that of the Long Term Athlete Development model (LTAD). Upon closer investigation of this specific model, the following could be determined: this model is being implemented by the Canadian Sports Centres/Canadian Sport for Life. They focus on “ten key factors” that direct and influence this athlete development model. These factors are listed, in no particular order, hereafter; 1) consideration for the developmental (biological) age in relation to the chronological age of the child; 2) the ten year rule to attain elite status; 3) the trainability of the child; 4) the "FUNdamentals", implying fun and participation over strenuous or systematic training; 5) specialisation (early versus late); 6) periodisation and time management; 7) the development and adaptation of mental, physical, emotional and cognitive abilities and attributes; 8) system integration and alignment, dictating the overall implementation of the developmental program; 9) calendar planning for competition, and; 10) continuous improvement and adaptation to the evolving demands of sport as sport-specific and scientific innovations dictate (Unknown Author, 2007a).

The LTAD further is made up of seven stages, including; 1) an Active Start; 2) the FUNdamentals; 3) Learning to Train; 4) Training to Train; 5) Training to Compete; 6) Training to Win, and; 7) Active for Life. The first three stages focus on overall physical literacy and mass sport participation, the next three stages focus on developing excellence, with the last stage focusing on lifelong sport participation and physical activity (Unknown Author, 2007b).

A further search for other developmental programs within literature came upon the work of Martindale *et al.* (2007) who provide specific guidelines for talent development. These guidelines for talent development programs are; 1) these programs need to communicate a message that emphasises support for the youngster and that is understandable to all involved; 2) the focus must be long-term and this focus must inform the purpose and vision of the program; 3) a developmental emphasis is critical and early selection must be strongly discouraged; 4) sport-specific skills need to be integrated into development in a systematic manner, and; 5) development must be ongoing allowing for progress at an individual pace. These same findings were made by Martindale *et al.* (2005), who were cited by Vaeyens *et al.* (submitted) earlier.

This search also uncovered the work of Bailey and Morley (2006). These authors listed a couple of factors that they considered before developing their model of talent development in a physical education setting. Their considerations included; 1) that a distinction should be made between performance and potential; 2) an acknowledgement that abilities are multidimensional in nature; 3) a specific physical education focus, as opposed to a sport focus, and; 4) an understanding of the fact that many factors can influences the development of ability in an individual.

And then, there is the DPYPS proposal contained in the other prominent document in this review, i.e.: Abbott *et al.* (2007). Recently, **sport**scotland implemented the DPYPS to address two major aims. These are the development of, 1) psychomotor and, 2) psycho-behavioural abilities in children. This was conducted by providing all children with a curriculum to adequately address these abilities. This curriculum was implemented at primary school level in physical education as well as classroom settings. The philosophy of this program is to assist children in reaching their fullest potential and to stimulate the life-long participation in sport and physical activity. The initial program ran for almost two years from beginning 2002 till end 2003, but the initial findings were positive. The authors also state that the findings of this initial implementation of DPYPS will then be used to develop a Long Term Player Development (LTPD) model that will be implemented by most governing bodies to further develop sport in the country. But, quite prominent is that the focus of this program was the overall development of many, and not early identification or selection, or lack thereof.

And, the final talent development approach encountered in this search was the strategy adopted by Sport and Recreation New Zealand (SPARC). This strategy focuses on and prioritises the establishment of a long-term developmental process that incorporates a specific talent identification function within this developmental process. The main aim of the talent identification application is to identify “indicators of potential” that provide them with an idea of the chances or probability of an individual to attain eventual success (Mahon, 2004).

From these very recent models and reviews that have been presented, it can certainly be seen that the sentiments of Vaeyens *et al.* (submitted) have tapped into the pulse of the general feeling and approach toward talent identification and development. It is now abundantly clear that the focus seems to be shifting. And, while talent identification as such may not be halted, it seems as if its role is now becoming one of monitoring or facilitating the development of talent in general. The specific selection or identification function that distinguishes between more and less able individuals seems to be falling out of favour, if the evidence is anything to go by.

2) Monitor progress, not performance

An aspect underscored by Vaeyens *et al.* (submitted) is that of current ability versus future performance. They say that a vital aspect of talent identification models is that they need to distinguish between current adolescent performance and their ability to improve. It is unfortunate however that not many talent identification models recognise this distinction and that talent and ability is still made according to current ability only (Abbott & Collins, 2002; Vaeyens *et al.,* submitted). They also note the sentiments of Gimbel (1976), Harre (1982) and Havlicek *et al.* (1982), who advocate for exposure to training and practice before making predictions on future performance. The specific aspects of these models were underscored at the beginning of this chapter.

Once again, there is a call for longitudinal studies on talent identification by Vaeyens *et al.* (submitted), and once again reference can be made to the original problems that Régnier *et al.* (1993) encountered in their review of the models of talent identification, as well as their recommendations for longitudinal studies in talent identification. Furthermore, du Randt and Headley (1992c) bemoaned the lack of these long-term studies many years ago, and therefore the point can be emphatically made that this is a matter in need of some serious attention. Some (Pienaar & Spamer 1998; Hare, 1999; Falk *et al.,* 2004; Vaeyens *et al.,* 2006; Elferink-Gemser *et al.,* 2007; Lidor *et al.,* 2007) have tried, but more needs to be done.

Vaeyens *et al.* (submitted) make mention of a "talent validation" process recently incorporated into UK Sport that consists of a three to six month training program in which those individuals identified as talented are subsequently exposed to the requirements of elite sport. This talent validation serves as a confirmation of the initial judgement, and is not a bad idea to implement. But, the need for longitudinal studies remains.

3) Biological maturation

Vaeyens *et al.* (submitted) then return to the issue of maturation. The impact of the relative-age effect is noted by the authors once again (please see the "problem" section of this review for reference, along with chapter four). Vaeyens *et al.* (submitted) do make mention of new methods of determining maturity status that are non-invasive in nature and design, but they specifically recommend that comparisons in ability be made according to biological age based norms as opposed to norms based on chronological age.

4) Accurate representation of tasks and multidimensionality in approach

Another recommendation of Vaeyens *et al.* (submitted) has to do with the need to design representative tasks that allow for reliable identification, as well as the need for a multidimensional approach to talent identification. The authors, in referring to the first stage of Ericsson and Smith's (1991) expert performance approach, recommend that talent identification try to more accurately define and determine the skill required in superior task performance within a sport. This would then allow for the creation of tasks that more reliably identify and measure the superior performance exhibited in successfully completing these tasks.

This study proposes that the best possible solution for this would be to conduct a thorough task analysis of the game at hand, as recommended by the conceptual model of Régnier (1987) in Régnier *et al.* (1993) discussed earlier in this section.

Vaeyens *et al.* (submitted) say that multidimensionality needs to be highly prized, and they point to a recent increase in prominence of this approach, with them noting ever more studies (Reilly *et al.,* 2000b; Nieuwenhuis *et al.,* 2002; Elferink-Gemser *et al.,* 2004; Falk *et al.,* 2004; Vaeyens *et al.,* 2006) that are adopting a multidimensional design. In adopting the same methodology as these preceding studies, discriminant analysis has revealed that technical and perceptual-cognitive skills distinguish more between skilled and less skilled individuals than anthropometry or physiology, with the studies of Williams and Reilly (2000b) and Elferink-Gemser *et al.* (2004) proffered by the authors as proof thereof. This is also the opinion of Williams and Ward (2007), as chapter five pointed out earlier.

And, while Vaeyens *et al.* (submitted) make the point that these skills not only enable effective, multi-domain performance (Williams & Ward, 2007), but are also reliable discriminators of skill and ability (Reilly *et al.,* 2000b; Vaeyens *et al.,* 2007), this issue was extensively underscored in chapter five of this study, as was the possibility of including tests for these skills within talent identification protocols, although the conclusion was made that rugby is a highly complicated sport and that this would be difficult. The relative dearth of technical and psychological considerations in talent identification is rather apparent however (Morris, 2000; Abbott & Collins, 2004; Vaeyens *et al.,* submitted). Vaeyens *et al.* (submitted) go on to echo the point raised earlier in this study, namely that researchers need to focus more on developing measures of performance that more accurately mimic the demands of real performance tasks with a move toward test protocols that more reflect real-world demands.

According to this present study, as the realisation continues to grow that it is the perceptual-cognitive and technical (skill) levels that tend to discriminate the performance abilities of individuals, it is hoped that ever more focus on these factors will come to light. It is as a result of this realisation that this specific study has attempted to focus more on these aspects, as chapter seven hereafter shows.

Vaeyens *et al.* (submitted) do make some final observations of the inherent limitations of talent identification. For their part they also acknowledge the limited resources that sport organisations have and the increased focus on talent identification and development as a result. They further point out that certain sports such as soccer require early specialisation, whereas others such as rowing don't. They go on to say that in single skilled sports it is easier to predict future success than in multi-skilled sports, in agreement with the original observations of Régnier *et al.* (1993), with the same applying for closed versus open skilled sports.

Their final recommendations based on these observations are that talent identification assist coaches and talent scouts in their respective duties, and that the testing of athletes be used to evaluate these athletes with regards to their specific areas of weakness so that this can further assist in their development. They also recommend that each sport has a specific talent identification model, along much the same lines as the original proposals of du Randt and Headley (1992d).

Therefore, in conclusion of this sub-section; the problems associated with current talent identification models are, for the most, not new concerns. The realisation of the need to address these issues can be described as the same. The recommendations provided in this section are certainly significant, as they are practical. The recommendations are therefore not only endorsed by this study, but, have also been attempted to some extent.

New tests were designed, and old tests modified in striving after this ideal. Furthermore, a perceptual-motor/cognitive test was added to the protocol. While the testing for this study was conducted before this review article came to light, the very content of this article confirms in a positive sense the initial initiatives behind the protocol adopted and adapted. It is hoped that while these steps are tentative at first, this study can continue in the rich tradition of its forbears, namely the work of Pienaar, Spamer and others.

### 6.4.2 Genetic doping and testing

Another trend that is increasingly evident in recent times is that of gene doping and modifications (McCrory, 2003; Sheridan *et al.,* 2006; Trent & Alexander, 2006; Klissouras *et al.,* 2007) as well as genetic testing for talent identification and sport guidance purposes (McCrory, 2003; Reilly & Gilbourne, 2003; Sellenger, 2003; MacArthur & North, 2005, 2007; McCrory, 2005; Savulescu & Foddy, 2005; Miah & Rich, 2006; Paul *et al.,* 2006; Sheridan *et al.,* 2006).

Klissouras *et al.* (2007) clearly indicate their uneasiness with the spectre of gene doping and modification and state their fear that progress in the area of genetic technology may enable athletes to improve oxygen transport and circulation within the body. According to them, the possibility of athletes being able to genetically alter their muscle strength and size quite considerably is also a real one. When it is considered, as McCrory (2003) note, that the International Olympic Committee has placed genetic doping on its 2003 list of banned practices, it seems as if the practice of genetic doping and gene transfer are already serious considerations in professional sport worldwide.

By using an adenovirus to deliver the EPO gene in monkeys and mice, Leiden *et al.* (1997) in McCrory (2003) found that the effect lasted for twelve weeks in the monkeys and almost a year in mice. Their specific findings were that this almost doubled the haematocrit levels in both the monkeys and the mice. McCrory (2003) are of the opinion, though, that detecting gene doping will be difficult.

The risks concerning gene doping are relatively unknown (Trent & Alexander, 2006) while Sheridan *et al.* (2006), in raising their safety concerns regarding this practice, also conceptualise the anti-gene-doping and anti-genetic-selection stance based on athletic tradition and morality.

And, while safety is admittedly a problem with gene doping, the option of genetic testing for performance and talent identification seems to be an option that is attracting quite a bit of interest (Savulescu & Foddy, 2005; Miah & Rich, 2006). The technology has now advanced to such a level that a mere cheek swab (Savulescu & Foddy, 2005) can test for the *ACTN* R577X allele. This gene, in various formats, has been found to play a role in the number of fast twitch fibres an individual has, and therefore a greater propensity and ability in power and speed based events (Yang *et al.,* 2003; MacArthur & North, 2005, 2007; Savulescu & Foddy, 2005).

The perspective of MacArthur and North (2005; 2007) with regards to genetic testing for talent identification can be seen as being *cautious*. MacArthur and North (2005) do go on to make the point, however, that while genetic testing might not yet be used to determine the potential of young athletes to attain elite status in sport, it could perhaps still be used to determine the sports and event types these youngsters would be best suited to. This position of the authors could probably be described as talent guidance.

In other related and certainly interesting findings, the ratio of the length of the index finger (2d) to the ring finger (4d) has been found to provide an indication of potential ability in sporting endeavours, in men (Manning & Taylor, 2001), and women (Paul *et al.,* 2006). These (and other) researchers have found that a low index finger to ring finger ratio (in other words, the shorter the index finger is in relation to the ring finger, the better) is indicative of higher foetal (prenatal) as well as adult testosterone levels, with these testosterone levels contributing to higher levels or potential levels of performance in sport. Other studies mentioning this finding include Reilly and Gilbourne (2003) who refer to work of Manning *et al.* (2003) in this regard.

Paul *et al.* (2006) even go as far as to say that these findings might even be helpful in predicting one's potential in a sport, although Reilly and Gilbourne (2003) seem to be of the opinion that the efficacy of this approach and finding and the value of these to talent identification would be limited.

The general feeling toward genetic modification in sport can be summed up in a series of letters to the editor of the British Journal of Sports Medicine in 2000. This rather amusing exchange of ideas and opinions starts with a less than endearing letter from Lavin (2000) in response to the statement of Montgomery and Woods (1999) in Lavin (2000) in which they express their concern that genetic technology and know-how may be abused in a sport setting. Lavin's (2000) opinion is that the chance is great that sport, that has a history of the misuse of science, will almost certainly proceed to misuse this genetic science too, and then proceeds to describe all elite athletes as freaks and out of touch with reality. In response to Lavin (2000), Montgomery (2000) continues his fretting about the potential to misuse of this genetic technology but also justifies their (Montgomery & Woods, 1999 in Lavin, 2000) original stance. At this stage Sharp (2000) enters the debate with a sharp rebuke of Lavin (2000) while offering a glowing tribute to the virtues of sports stars everywhere.

While the afore-mentioned findings and debates have the potential to excite or amuse, there are some very serious implications to genetic testing in sport and talent identification. Hoberman (2007) notes that there seems to be an ongoing process whereby ethical considerations within sport are becoming less and less considered in favour of better and improved performances (and ways of improving these performances), and that on the whole, self-restraint seems to be diminishing. Sellenger (2003) in turn is of the opinion that in applying genetic testing to the sporting environment, certain economic, ethical and legal issues are certain to arise. Discrimination on the grounds of genetic makeup and the removal of personal freedoms are some of the concerns raised by him.

Sellenger (2003) goes on to briefly discuss the *ACE* I/D and the *ACTN3* R577X findings, along with other genetic influences on performance, and throughout the text thoughtfully considers the potential legal and ethical impact that genetic testing can have on the sport industry and participants. It is recommended that anyone interested in these issues from an ethical, moral and legal perspective, read Sellenger (2003) for an intuitive insight into these matters.

In sum, there are serious concerns that need to be considered by those contemplating the advancement of this alternative form of talent identification or performance enhancement. The chances of either practice "just stopping there" are small when economic considerations are brought to the table. The stance of this study with regards to genetic testing in talent identification is cautious yet optimistic while still holding to the views of Miah and Rich (2006:259) who *"…argue that genetic tests for performance might violate the child's right to an open future and that this concern should be taken into account when considering how and whether such tests should be used."*

## 6.5 SANZAR APPROACHES TO TALENT IDENTIFICATION AND DEVELOPMENT

In this section the talent identification and development approaches of South Africa, New Zealand and Australia are summarised and presented. The information was obtained directly from the South African Rugby Union, the New Zealand Rugby Union and the Australian Rugby Union.

A questionnaire was developed and sent via electronic mail (e-mail) to the relative contact persons at the New Zealand Rugby Union and the Australian Rugby Union. This questionnaire was completed by the relevant parties and then subsequently returned. In the case of the South African Rugby Union, the information was obtained by completing the questionnaire through telephonic interviews.

The contact person at the South African Ruby Union was Mr. Herman Masimla who is the manager of High Performance at the union. Further information was obtained from Mr. Justin Durandt, manager of High Performance at the Sport Science Institute of South Africa (SSISA), and Mr. Nico Serfontein of the Blue Bulls Rugby Union. The contact person at the New Zealand Rugby Union was initially Mr. Mark

Robinson and then subsequently Mr. Andrew Hore who assisted with this questionnaire on behalf of the union. The contact person at the Australian Rugby Union was Mr. Ben Whitaker who is the National Teams and Programs Manager for the union.

The information contained in this next section can therefore be regarded as reflecting the most contemporary and recent practices of the respective rugby unions, although it must be stressed that the information originates totally from the sources mentioned above. This feedback will be reported along the same structure and a copy of the questionnaire can be found in Appendix A of this study.

### 6.5.1 Talent identification and development at the South African Rugby Union

The information contained in this section is a summary of the feedback from both Mr. Herman Masimla and Mr. Justin Durandt. Therefore, the reporting of their feedback in this section is represented as a combined view. Extra information from Mr. Nico Serfontein, of the Blue Bulls Rugby Union, is also included in this section. Mr. Serfontein is in charge of high performance at the Blue Bulls Rugby Union. All the information in this section was obtained via telephonic interviews with these individuals based on the questionnaire.

#### 6.5.1.1 Talent identification

At national level, talent identification is incorporated into the overall South African Elite Squad System. This elite squad system in its current format was introduced at the beginning of 2007 by the South African Rugby Union. It must therefore be stressed that this is a new process that is undergoing a certain level of development and refinement as the process progresses. This new approach blends certain existing practices with new practices. In other words, some of the approaches described in this section have been implemented before and some are in the process of being implemented for the first time (J. Durandt, personal communication, 2007; H. Masimla, personal communication, 2007).

Furthermore, at the beginning of 2007 the fourteen provinces in South Africa signed agreements to adhere to the testing protocol of SA Rugby as well as to use the full testing kit that they purchase from SA Rugby. The provinces also contract full-time Biokineticists to perform this testing and monitoring. As a result, all testing and subsequent conditioning of these players selected to the South African Elite Squad occurs at provincial level. An important note in this regard is that the specific testing and subsequent conditioning, while performed at provincial level, is supported by SSISA, who are involved in the actual roll out process. SSISA are also involved in training the unions with regards to the testing and conditioning (J. Durandt, personal communication, 2007; H. Masimla, personal communication, 2007).

This elite squad system operates as follows:
At national level, talent identification occurs at U/16 level where eighty players are identified by the selectors to be included into the South African Elite Squad at the U/16 Grant Khomo week. The selectors involved in this process are the national Springbok selectors, the South African U/19 coach and selector as well as two South African School team selectors. The eighty selected players are then returned to their home unions where they are then tested by their home unions according to the testing protocol (included hereafter) of SA Rugby (J. Durandt, personal communication, 2007; H. Masimla, personal communication, 2007).

The next step in this process is that these players are subsequently included in a provincial U/16 elite squad consisting of thirty players. These thirty players consist of the players selected at national level (members of the SA Elite Squad) and other promising players from the province who are added to the squad to round out the numbers. This provincial elite squad is primarily supported by the home union, while the nationally selected players (members of the national elite squad) within this provincial elite squad receive extra support from SARU and High Performance in the form of supplements and further (specialist) support if needed (J. Durandt, personal communication, 2007; H. Masimla, personal communication, 2007).

These nationally selected players then stay in the system for a year and progress on to form the U/17 national elite squad for SARU and the respective home provinces. At the end of their second year they exit the system unless they are re-selected for the U/18 South African Elite Squad at the U/18 Craven Week. An inherent quality control mechanism for this identification, selection and development process of the elite squad system of South African rugby and the respective provinces is that those individuals (or as many of them as possible) selected to the South African Elite Squad at U/16 level and subsequently developed at provincial level should ideally be included in the South African Elite Squad at U/18 level, selected at Craven Week. These players would then still be monitored by SARU and would receive further development. These players should preferably progress on to the provincial U/19 and U/21 rugby teams and hopefully the corresponding national age-group teams (J. Durandt, personal communication, 2007; H. Masimla, personal communication, 2007).

Each province also employs talent scouts who inform SARU about talented players at U/16 and U/18 levels and also give feedback to SARU regarding player performance at U/19 and U21 level with the eye on the IRB U/20 World Championships to be played next year. As noted, the age formats are changing with the IRB U/20 World Championship being played for the first time at this age-group in 2008. This will also impact the junior professional ranks of rugby players with SARU and the provincial unions reverting to a U/20 format as of next year (J. Durandt, personal communication, 2007; H. Masimla, personal communication, 2007).

At time of writing, testing is performed at all levels in SA Rugby, but is unfortunately still not standardised at all levels. One example of this is at Super 14 level. Some franchises choose to make use SA Rugby protocols, whereas others choose not to. At the current moment the U/16, U/17 and U/18 elite squads, as well as the South African U/19 squad and the Senior Springbok team all make use the same protocol, with the data from U/16-U/19 centrally stored. The central SARU database is currently in the process of being redone. But, in spite of this fact, the data from the age-groups U/16 to U/19 can be objectively compared with one another (J. Durandt, personal communication, 2007; H. Masimla, personal communication, 2007).

Since this new elite squad program was only started in 2007, there are, however, cases where the approach is not followed in the way as just described. An example of this difference in approach to the elite squad is at the Blue Bulls Rugby Union. This union only has one school elite squad consisting of 45 players ranging from U/14 to U/17(U/18) level. Those individuals chosen at the Grant Khomo week to be part of the National Elite Squad of SARU are incorporated into this provincial elite squad system and are monitored, tested and developed in accordance to the requirements of SARU. This difference in approach is however done in full consultation with SARU who are kept abreast of developments and progress at all times (N. Serfontein, personal communication, 2007).

A final consideration regarding this whole approach is that there are two junior rugby systems operating within rugby in South Africa. These are the following:

1) The schools elite squad system ranging from U/14 to U/18. It is in this system that the National Elite Squad System for SARU (U/16, U/17, U/18) and the corresponding elite squads for the respective provincial unions operate.

2) The junior professional ranks incorporating the U/19 and U/21 (this will be changing to U/20) age groups of SA Rugby, and the respective provincial unions.

It can then be said that the ideal scenario should be that those who have progressed through the national and provincial elite squad (schools) system should move on to the junior professional ranks, with this being an indication of the success of the talent identification and development initiatives of SARU and the respective provincial rugby unions (N. Serfontein, personal communication, 2007).

*6.5.1.1.1 Testing protocol SARU*

The testing protocol that is used to test and profile the elite squad members has many specific tests that can be assigned to the broad categories of anthropometry, physical-motor and flexibility. The protocol is included hereafter:

**Table 6.1: Testing protocol of South African Rugby Union ***

| Anthropometric | Flexibility | Physical-Motor |
|---|---|---|
| 1) Height (cm)<br>2) Weight (kg)<br>3) Body composition (7 skin-folds)<br>• Biceps<br>• Triceps<br>• Sub-scapular<br>• Supra-iliac<br>• Abdominal<br>• Mid-thigh<br>• Calf<br>4) Girths (cm)<br>• Mid-thigh<br>• Calf<br>• Forearm | 1) Sit and reach (cm)<br>2) Straight leg raise (degrees)<br>3) Modified Thomas Test<br>• Hip flexion (degrees)<br>• Quadriceps (degrees) | 1) Vertical jump (cm)<br>2) Standing broad jump (cm)<br>3) 10/40m sprint (sec)<br>4) Illinois agility test (sec)<br>5) Strength<br>• Bench press (kg)<br>• Pull-ups underhand (max)<br>• Push ups (max in 60 sec)<br>6) Multi-stage shuttle run (bleep test) (shuttles)<br>7) 5m shuttle run (m) |

** Rugby-specific skills tests were initially utilised but these have subsequently been phased out. SARU are currently reviewing this matter.*

As noted in this sub-section, rugby-specific skills tests are no longer incorporated into the SARU testing protocol. This is currently under review, but remains a concern that should be addressed as a matter of importance, since it is not in keeping with the recommendations from older and more recent literature, or even general practice.

#### 6.5.1.2 Talent development

Each province has someone specially appointed to be in charge of the high performance initiatives at that province. This individual coordinates the process of development and monitoring of these elite players who are part of the national elite squad, although they also monitor those members who are only part of the provincial elite squads too. As stated earlier, the players previously selected to be part of the national elite squad are sent back to their provinces and subsequently incorporated into the provincial elite squad. These elite squads undergo intensive physical development and conditioning as well as skill development (J. Durandt, personal communication, 2007; H. Masimla, personal communication, 2007).

This high performance manager, often in conjunction with the provincial U/19 or U/21 coach then assesses the players' rugby-specific skills. If they encounter any short-comings with their skills, they then arrange specialist coaching for these individuals in this area of their short-coming. This is done in conjunction with SARU who provide financially for this specialist coaching. As an example of this, an individual might be found to have a short-coming in their kicking technique or ability and be in need of specialist coaching in this area. It must be noted however, that this support received from SARU for this specialist coaching in most cases only applies to those members of the provincial elite squad who are also members of the national elite squad (J. Durandt, personal communication, 2007; H. Masimla, personal communication, 2007).

Another important requirement is that the provinces provide SARU with a monthly feedback report on the progress of the national elite squad members within the provincial elite squads (J. Durandt, personal communication, 2007; H. Masimla, personal communication, 2007).

Further development initiatives of SARU and SA Rugby are the junior and the senior squads of the High Performance Program. The junior squad of the High Performance Program consists of those players identified at the SASSU Tertiary

Institution Week, Currie Cup U/19 players, some of the U/18 Elite Squad players as well as players selected by the provincial talent scouts. The players in this squad are profiled according to their personal information in the form of conditioning and medical reports. Furthermore, a technical review is performed on these players and they then receive an action plan for further development. The specific aim of this process is to develop these players for the U/20 World Cup. As noted earlier, the first World Cup of this new age-group format will occur in 2008. A position-specific training camp will take place at the end of the 2007 national U/19 Currie Cup competition to prepare the players for the World Cup. Trials will be played (North and South) to select specific players for inclusion in the team that goes to the World Cup (J. Durandt, personal communication, 2007; H. Masimla, personal communication, 2007).

The senior squad of the national High Performance Program has been established to develop the Emerging Springbok team. Fringe players from outside the National Springbok squad as well as Super 14 players and those selected by the national selectors are included in this senior high performance squad. These players are also profiled according to their personal information (conditioning and medical status, as well as technical review) and action plans for further development are drawn up for these individuals (J. Durandt, personal communication, 2007; H. Masimla, personal communication, 2007).

In summarising the talent identification and development approach of SARU:

It is evident that the initial identification and selection of players is performed by selectors and occurs at the age of sixteen years. These selected players then form the South African Elite Squad. They are sent to their unions to form part of the provincial elite squads where they are physically profiled and tested as well as monitored for skills deficiencies. There they receive conditioning and skill-specific (if needed) training. These players are monitored through the ranks and hopefully progress to the U/18 Craven Week, the junior professional ranks and beyond. There are also junior and senior squads of the High Performance Program of SARU. The junior squad's focus is on the IRB U/20 Rugby World Cup and the senior squad's main focus is on the Emerging Springbok Team.

#### 6.5.2 Talent identification and development at the New Zealand Rugby Union

Initial correspondence was with Mr. Mark Robinson. Thereafter, Mr. Andrew Hore assisted with the information in this section and is referred to throughout. Correspondence was in the form of electronic mail.

##### 6.5.2.1 Talent identification

Historically, talent identification in the New Zealand Rugby Union (NZRU) has been performed on a largely informal basis. Age-grade provincial selectors and coaches normally form the basis of this network and, the national coaches and selectors choose their teams based on the competitions at provincial level. There are no structured reporting systems or formal lines of communication in talent identification in rugby in New Zealand (A. Hore, personal communication, 2007).

Talent identification is conducted at U/16 level by means of regional tournaments (North/Central/South) (these are the competitions mentioned in the previous paragraph) between provincial unions and this forms the basis of talent identification in New Zealand. The National U/17 selectors choose an elite squad of fifty players who are invited to attend ongoing national development camps the following year. It is at these camps where the strengths and weaknesses of the players are assessed and where their physical conditioning is measured. These identified players usually progress through the national age-grade system, get to play in international matches and also attend further development camps, but this is conditional on them maintaining their high standards of play (A. Hore, personal communication, 2007).

Furthermore, in attempting to improve the overall approach to talent identification in the NZRU, they recently appointed a Talent Identification Manager. It is this person's role to perform a coordinating role that includes the establishment and implementation of official talent identification and development structures and systems within the NZRU. This person also reviews current practices. The NZRU currently has approximately seventeen selectors who are applied across the U/17, Secondary School, U/19 and U/21 teams. These are unpaid positions, although the NZRU does cover their costs. These selectors in turn have a network of teachers, selectors and coaches in the provincial unions on whom they can rely. These structures also fulfil a talent identification role throughout the country, and once a talented player is identified through these structures, they are tested by the Super Rugby Franchises (A. Hore, personal communication, 2007).

The physical testing protocols in use in New Zealand Rugby Union are consistent from age-grade level through to the elite professional levels. The NZRU currently use a central database called the Performance Profiler that holds all the information around the athlete's testing, conditioning and nutrition (A. Hore, personal communication, 2007).

*6.5.2.1.1 Testing protocol NZRU*

The testing protocol that is used to test and profile those athletes identified by the selectors is divided into anthropometric and physical-motor variables. Furthermore, as with SARU, NZRU do not employ rugby-specific skills components in their testing. They are currently in the process of developing a skills assessment that will focus on core skills such as tackling, passing, running and catching skills which in turn are centred on three rotations of running lines, tackle technique and catch/pass skills (A. Hore, personal communication, 2007).

These skills will be scored on a qualitative, ranking system as opposed to a quantitative approach since the assigning of scores is a subjective practice that often varies between different assessors. The NZRU feel that a qualitative approach allows for the specific targeting of skill deficiencies without being overly concerned with scores that might not sketch the proper scenario as to overall and specific performance of a skill (A. Hore, personal communication, 2007).

The protocol is included hereafter:

**Table 6.2: Testing Protocol of New Zealand Rugby Union**

| Anthropometric | Physical-Motor |
|---|---|
| 1) Height (cm)<br>2) Weight (kg)<br>3) Body composition<br>(8 skin-folds)<br>• Biceps<br>• Triceps<br>• Sub-scapular<br>• Supra-iliac<br>• Supra-spinal<br>• Abdomen<br>• Mid-thigh<br>• Proximal calf | 1) MFITS *<br>• 60m (sec) (to measure acceleration, the backs are timed at 10m and 30m and the forwards and halfbacks at 10m and 20m)<br>• 400m (sec)<br>• 1500m (sec)<br>2) $RS^2$ Test **<br>3) Strength and power (1-5RM)<br>• Power clean (kg)<br>• Deadlift (kg<br>• Back squat (kg)<br>• Bench press (kg)<br>• Flat dumbbell press (kg)<br>• Weighted reverse grip chin (kg)<br>• Bent over row (kg) |

** MFITS=Multi Energy System Assessment.*

*** $RS^2$=Rugby Specific Repeated Speed Test-this test incorporates an agility component to the testing.*

### 6.5.2.2 Talent development

The development of talent in New Zealand rugby is, as with SARU, particularly well managed. Each provincial union has an academy structure for player development. Often these players can spend as much as three years in this development program.

The NZRU has also introduced an elite academy program into the provincial union academy program. This allows them to more closely monitor the elite squad (and other) players who they think will perform at the highest level in the future (A. Hore, personal communication, 2007).

At national level, the NZRU use their national age-grade camps, which in the past have traditionally been trials to select national teams, to further develop those players selected for national-age grade representation. At these camps there is however now more of a focus on the further development of the athlete and less of a focus on trial games. Issues that are focused on include such diverse yet critical factors such as leadership, nutrition, conditioning, game and positional awareness, review systems, self and social awareness and self-management. All of these are believed to be crucial to the success of the athlete. Through these camps the NZRU aims to provide the latest knowledge and expertise by introducing the most recent techniques and developments that are available to rugby (A. Hore, personal communication, 2007). Do note that these age-grade camps are *not* the same camps as those used to develop the players selected at U/16 level by the national U/17 selectors.

The managers of the provincial union academies are invited to the national age-grade camps mentioned earlier, and with the knowledge that they gain at these camps, they then go back to their respective provincial academies to so improve the functioning and offering that they provide on a provincial basis. (A. Hore, personal communication, 2007).

In summarising the talent identification and development approaches of the NZRU, the following can be said:

The NZRU also identify players at U/16 level. They then get invited to national elite training camps for further development in the following year where their strengths and weaknesses and their physical profiles are established. It is these players that usually progress through the elite representative ranks but are required to maintain their standards. The NZRU also employ national age-grade camps to further develop the players selected to represent New Zealand at age-grade level. Development in NZRU appears to be based at provincial academy level where players are developed. An elite academy program has been introduced at these provincial academies where the elite group initially selected (and other players) are monitored and further developed. It certainly seems as if a lot of effort goes into the provincial and national academy setup.

### 6.5.3 Talent identification and development at the Australian Rugby Union

All correspondence in this section was with Mr. Ben Whitaker of the Australian Rugby Union. Correspondence was in the form of electronic mail.

#### 6.5.3.1 Talent identification

The ARU performs talent identification country-wide and have talent identification coordinators in the four Super-14 provinces with further talent identification networks extending from these coordinators into the larger metropolitan and country areas. Talented players are first identified and recruited from the ages of 14 to 15 years. Pertinent to note, however, is that while the ARU also uses age-group tournaments to identify talented youngsters, these tournaments are more often than not used in conjunction with the well established talent identification networks country-wide (B. Whitaker, personal communication, 2007).

Over the past four years the ARU have used a consistent battery of physical tests that have been used as objective measures of the player's ability to succeed. Furthermore, the results from these tests provide the ARU with an indication of what is needed to assist these individuals in reaching the higher levels of the game as well as succeeding therein once at these levels (B. Whitaker, personal communication, 2007).

The ARU use the same battery of tests all representative teams, from the youngest age-group programs (14-17 years) through to Super 14 and Wallaby level. Over the past four years they have implemented standard testing to collect data that can be used to assess standards throughout these various years. The ARU have acknowledged the need to build on this data over the next five years in order to facilitate comprehensive analysis of the data obtained. Also, while it is possible for the ARU to compare intra and inter-group test results, there is a hesitance to do so. They rightly consider the need to appreciate the intra and inter-group differences that occur during physical development and maturation (B. Whitaker, personal communication, 2007).

The ARU have sufficient strength and conditioning positions to allow for ‘in house’ talent identification and testing. They do make use of the Australian Institute of Sport as external counsel to challenge and question the test their approaches and practices. Furthermore, to ensure that they retain the requisite levels of non-bias and objectivity, the ARU make use of external groups to perform their testing (B. Whitaker, personal communication, 2007).

So, the ARU has identified two key areas that need to be in place for effective talent identification; 1) established positions to ensure sufficient and adequate coverage across Australia to facilitate the identification of the best talent, and; 2) a standard process that ensures that all the individuals and groups involved understand what they are looking for and how the information is channelled through to the right people (B. Whitaker, personal communication, 2007).

One of the major challenges faced by the ARU is the fact that rugby league, and to an extent Australian Football are looking for players that fit the same profile as those needed by rugby union (ARU). They are therefore constantly under pressure to ensure that their systems and ability to recruit and retain talent are the best that they can be (B. Whitaker, personal communication, 2007).

*6.5.3.1.1 Testing protocol ARU*

**Table 6.3: Testing protocol of Australian Rugby Union**

| Anthropometric | Physical-Motor |
|---|---|
| 1) Height (cm) | 1) 10/20/40m sprint (sec) |
| 2) Weight (kg) | 2) Vertical jump (cm) |
| 3) Body composition (7 skin-folds) | 3) Beep test (shuttles) |
| • Biceps | 4) Strength* |
| • Triceps | |
| • Sub-scapular | |
| • Supra-spinal | |
| • Abdominal | |
| • Front-thigh | |
| • Medial-calf | |

** Duthie (2006) recommends squats (kg) and bench press (kg) as strength tests for elite rugby. It could not be ascertained whether the ARU actually incorporates these specific strength tests within their protocols.*

The ARU strive to provide an indication of the learning preferences of each player. This will aid in the coaching approach to be used on the players. Furthermore, they are also looking into conducting mental toughness reviews on each player to establish mental toughness profiles for these players (B. Whitaker, personal communication, 2007).

Skill testing is performed by the ARU. They divide rugby skills into core skills and position specific skills. Core skills are contact/breakdown, catching and passing as well as tackle/defence skills. They further classify individual or position specific skills to include those of scrumming, kicking (various types), lineout support, lineout throwing and lineout jumping. These skills are not tested as such in testing protocols but are rather analysed and qualitatively rated from the game performances of the individuals under review (B. Whitaker, personal communication, 2007).

This "best practice" skill/performance rating for each position was developed primarily in conjunction with the Super 14 and Wallaby coaches. According to this list of skills and the rating provided, if the player is able to perform each of these skills at the highest level or rating, then this would result in the player being the worlds best in that position. The ARU acknowledge, however, that it is not possible for a player to perform all the skills listed per position at the highest level or rating. They therefore regard this rating to be of as much value to players as it is to coaches and others. By using this rating, players' strengths and weaknesses are discovered and they can use this rating to assist them in developing their areas of need (B. Whitaker, personal communication, 2007).

The rugby-specific skills performance rating of the ARU is included hereafter:

**Table 6.4: Performance rating scale of the ARU for rugby-specific skills (Provided by Ben Whitaker, ARU)**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Able to perform the skill @ training with no opposition | Able to perform the skill @ training – (1 v 1) | Able to perform the skill @ training in game situation (eg 5 v 5) | Able to perform the skill in a game – *Schoolboy* *Club* | Able to perform the skill in a game @ national level – *Aust Schools* *Aust U19s* *Aust U21s* *Aust 7s* *S14 'A'* | Able to perform the skill in a game @ international level – *S14* *Aust 'A'* *Wallabies* |
| **Training** | **Training** | **Training** | **Game** | **National level game** | **International level game** |

#### 6.5.3.2 Talent development

Once a talented or gifted individual is identified, they are channelled into the National Talent Squad Program for 14-18 year old school players where they are appropriately developed over the long term. This program is conducted out of the four Super 14 provinces as well as out of Melbourne. Here, professionally staffed training centres provide the necessary development and included on the staff of these centres are full time coaches as well as strength and conditioning specialists. Thereafter, if these players are considered to be good enough, they then proceed to post school academies where their long term development is further continued (B. Whitaker, personal communication, 2007).

In summarising the talent identification and development approaches of the ARU, the following is apparent:

Talent identification is conducted at an earlier age by the ARU as opposed to SARU and NZRU. Further, their talent identification network is advanced and well developed in that they do not rely as much on age-group tournaments. Their test protocol for physical profiling is consistent throughout all representative age-groups and they also provide for skills testing in a qualitative manner. They are also considering mental toughness as a measure. Development then occurs in national school-age development programs country-wide, and if deemed good enough, these individuals proceed to post-school academy environments.

## 6.6 SUMMARY

From the preceding discussion it is clear that talent identification is constantly evolving. It is however quite apparent that talent identification is far from a perfect science and that more research and investigation is necessary before a complete and satisfactory multi-sport, multidisciplinary approach that adequately addresses all the inherent requirements of sport and the identification thereof is to be developed.

Talent is dynamic and is constantly changing. It is virtually impossible to assign a stable progression pathway to the concept of talent, especially in sport, since there are so many variables and attributes that play a role in successful participation, often with each of these attributes or variables developing at different rates (Vaeyens *et al.,* submitted). A possible solution to minimise or counteract this changing nature of talent (as especially found during childhood and adolescence) is to monitor longitudinally those players who initially show promise and then to use the data obtained from those who eventually achieve ultimate success for future comparison and measurement.

The challenges inherent to talent identification are not insurmountable however, and the relative short-comings as well as recommendations provided by Vaeyens *et al.* (submitted) as well as Abbott *et al.* (2007) really need serious consideration and implementation. When looking as far back as du Randt and Headley (1992c), Régnier *et al.* (1993) and others, with their emphasis of some of the problems, it is quite notable that little has been or can be done to address the issues concerned, although noteworthy attempts and progress have been made. It is also important that the guidelines and recommendations of du Randt and Headley (1992d), Régnier *et al.* (1993) and Vaeyens *et al.* (submitted) be heeded. South Africa is a worthy participant in the international sporting arena and world beaters in many sports. For South Africa to consistently be and beat the best, a scientific approach to talent identification and development is critical.

The SANZAR review contained in this chapter was meant to analyse current talent identification and development trends and practices only. The information was gathered from the officials (and one sport scientist) actively involved in these processes at the respective home unions. Consequently, it must be said that scientific deductions were not made from this data and that this review did not serve as a scientific basis for this study.

Nonetheless, valuable and insightful information was garnered from this review and analysis of the talent identification and development approaches of the SANZAR nations. It is quite clear that proper developmental programs are currently in place in rugby. This bodes well for the future of the game internationally and locally. The question remains, however, as to how many potential Springboks and representative players are slipping through the cracks due to talent identification and development programs that may not yet be as effective as they should be.

In summary, the issues raised by the analysis of the models of talent identification and the subsequent proposals are significant. The critiques and possible solutions pertaining to talent identification provided by Vaeyens *et al.* (submitted), Abbott *et al.* (2007) and others are regarded by this study as having merit. The specific issues of; 1) maturation and related factors; 2) the dynamic and unstable nature of talent and its development, and; 3) a focus on talent development over identification and others are all further reinforced by this study. As is the multidisciplinary approach to talent identification that has been so resolutely championed by so many. It is only obvious that focusing only on physical variables is far from adequate, and an incorporation of sport-specific skill measures and psychological attributes and skills in overall talent identification protocols is not only important, but of absolute necessity.

The overriding emphasis of this study, however, is that when all things are considered, talent development be seen as the overarching concern, with talent identification functioning as a measure of accuracy and progress. Once overall movement, physical, perceptual and mental skills of players are stimulated and developed, and only once they have been exposed to a wide range of sports, then the selection of current ability and the identification of potential ability within a specific sport can and should be conducted.

# CHAPTER SEVEN

# EMPIRICAL INVESTIGATION

## 7.1 INTRODUCTION

The test protocol for this study can best be described as a combination of the tried, tested and established in conjunction with the highly experimental and evolutionary. As stated in chapter one and six, this protocol was broadly based on preceding successful test protocols used for research and talent identification in rugby. These studies include the original pioneering studies of Pienaar and Spamer (1995) in Pienaar and Spamer (1998) and Pienaar and Spamer (1996a; 1996b) thereafter. These early studies were subsequently followed by those of Pienaar and Spamer (1998), Pienaar *et al.* (1998; 2000) and Hare (1999) as well as by the more recent studies of Booysen (2002), Spamer and Winsley (2003a; 2003b) and Van Gent (2003). Subsequent to the completion of testing for this study, other studies such as Van Gent and Spamer (2005), Plotz and Spamer (2006) and Spamer and De la Port (2006) were found to once again use similar protocols to these preceding studies.

This chapter therefore serves as a description of the empirical investigation and methods utilised in this study. This study has two main aims. The first aim is to conduct an in-depth and exhaustive review of the literature so as to provide a sufficient foundation and basis for this study. This has been achieved in chapter's two to six. The second main aim is to provide an alternative sport and position-specific testing protocol as well as comparative results consisting of norms and scores that will adequately identify and select those capable of participating in elite age-group rugby union.

As will be seen in this empirical investigation and the discussion of the results in chapter eight, the larger proportion of the physical-motor, anthropometrical and sport vision testing utilised in this study consists of tests that already exist. Some of these tests are not commonly used within the existing and preceding talent identification protocols for rugby however. The incorporation of these tests was successfully achieved with norms established.

As is shown in this chapter, a number of existing as well as self-devised tests were included in this protocol for experimental purposes. Some of the self-devised tests were successful whereas others were not. The specific discussions surrounding these tests and their associated successes or short-coming are discussed in section 7.3 of this chapter.

### 7.1.2 Chapter outline

This chapter has been structured in the following way:

*Section one: reporting of interviews with national-level coaches*

Interviews were conducted with international level coaches and conditioners prior to and during the testing process of this study. This section provides a brief outline as to the findings and conclusions of this interview process.

*Section two: final test protocol*

This section briefly describes the tests that were discarded or modified through the course of the testing process. Thereafter, the sample group is described with this followed by a description of the final test protocol.

*Section three: statistical methods*

The statistical methods of this study are described in this section as well. This also includes the motivation for the simulations and the iterations incorporated within the results section of this study.

## 7.2 REPORTING OF INTERVIEWS WITH NATIONAL AND INTERNATIONAL-LEVEL COACHES

This section can be described as an evertical ("bottom-up") section of this study. It must be stated at the outset that a thorough task and game-analysis of the sport-specific requirements and the determinants of performance in rugby are assumed to be in place by virtue of the preceding test protocols on which this study is based. The purpose of this evertical interview section is to provide a review of the current views within rugby with regards to the requirements for successful participation from a physical, skill and psychological/vision related perspective. A copy of the interview form can be found in Appendix B of this study.

### 7.2.1 International and national level coaches and conditioners

The coaches and conditioners interviewed during this study are listed chronologically according to the date of interview or the receipt of their information. All the coaches except Mr. Nick Mallett (faxed questionnaire) and Mr. Robbie Deans (electronic mail) were interviewed on a one-on-one basis.

#### 7.2.1.1 Eugene Eloff (EE)

Eugene Eloff is currently the senior coach of the Lions Currie Cup team. In his junior provincial coaching career he claimed the National U/21 title in 1999 and Vodacom Cup trophy in 2002. In his junior international coaching career Eugene Eloff won two IRB World Championship titles with the South African U/19 team in 2003 and 2005. Eugene Eloff is also currently the coach of the Lions in the Currie Cup and Super-14 competition. Date of interview: 05/04/04

#### 7.2.1.2 Jake White (JW)

Jake White is the most recent Springbok rugby coach. He was coach of the South African U/21 team that became the IRB World Champions in 2002. He coached the Springboks to the 2004 Tri-Nations title and in the same year was appointed as the IRB World Coach of the Year. In 2007 Jake White coached the Springboks that won the IRB World Cup and he was once again appointed as IRB World Coach of the Year. Jake White's overall Springbok coaching career stands at 36 wins in 54 tests, boasting a 67% win ratio. This information is correct as of 24/11/07. Date of interview: 14/08/04

#### 7.2.1.3 Peter de Villiers (PdV)

Peter de Villiers was the coach of the South African U/21 side that became the IRB World Champions in 2005 and who were the runners up in 2006. He has achieved enormous success in junior rugby and is regarded as an individual with a great future in South African rugby's coaching ranks. Date of interview: 17/08/04

#### 7.2.1.4 Ashley Evert and Pieter Terblanche (AE/PT)

Ashley Evert boasts an extensive involvement with youth and senior rugby. He has coached successfully at U/21 level for the Blue Bulls Rugby Union and has been the assistant coach of the South African U/21 rugby team that placed third at the IRB World Championships in 2004 as well as the team that became the world champions in 2005. He is also currently the General Manager of the Blue Bulls Rugby College and is regarded as another of the rising stars within the coaching structures of South African rugby.

Pieter Terblanche is a Certified Strength and Conditioning Specialist with the National Strength and Conditioning Association. He has extensive sport-specific conditioning experience at the highest levels, first at the University of Pretoria and then subsequently at the Blue Bulls Rugby Union where he is in charge of the conditioning of the junior teams at the union. Date of interview: 08/09/04

#### 7.2.1.5 Nick Mallett (NM)

Nick Mallet is a former Springbok rugby coach and the current director of rugby for the Western Province Rugby Union. Nick Mallett is regarded as one of South Africa's most successful coaches ever with a record of 27 wins in the 38 (71%) tests the Springboks played under his guidance. Between 1997 and 1998 the Springboks completed a winning streak of 17 consecutive test wins under his leadership and coaching. Nick Mallet was also the coach when South Africa won the Tri-Nations competition in 1998 and he coached the Springboks to a third place at the 1999 IRB World Cup. The information was received from Nick Mallet subsequent to the first two testing sessions but prior to the last testing session. Receipt of completed questionnaire: 07/09/05

#### 7.2.1.6 Robbie Deans (RD)

Robbie Deans is currently the coach of the Crusaders, New Zealand and Super rugby's most successful franchise. Under his coaching the Crusaders have won four Super rugby titles. Since it was only possible to contact Robbie Deans after testing, his general inputs as to the different requirements in rugby are noted but were not applied to testing. Receipt of complete questionnaire: 18/11/06

### 7.2.2 Results of interview

Since this study has grouped the positions under loose-forward, tight-forward and backline players, the information in this section will be reported in the following way:

For each positional grouping, the following categories have been included: 1) general play; 2) physical-motor; 3) position and game specific skills, and; 4) psychological, vision, anticipation and reading of the game. Do note that for the purposes of *this feedback only,* any comments about stature, body size or weight were included under either the physical-motor or the general section of each positional grouping.

For each of these positional groupings, a brief excerpt of the general description from the original questionnaire is provided as an introduction to the section, with this introduction then followed by the feedback from the respondents under each of the afore-mentioned categories. Where relevant, information provided by the respondents pertaining to a specific position within these positional groupings is notated, since some of this feedback guided certain of the attempts at self-devised position-specific tests for this study. For specific positional information as contained in the interview form, please refer to Appendix B.

The format of this interview was based almost exclusively on the exhaustive position-specific literature review done by Van Gent (2003). Where possible, the original studies cited by Van Gent (2003) were accessed and therefore reported as such. Since Van Gent's (2003) position-specific analysis was done on every position, the interview form was constructed in the same way. But, since the positional groupings for this study consist, as just reported, of tight-forward, loose-forwards and backs, the reporting of the interviews has been provided in the same way. As a result, the opinions considered the most generic or able to be generalised across all positions within each positional grouping have been included, with these opinions provided in a summarised format. At the end of this interview section a brief summary of the findings will be provided.

#### 7.2.2.1 Tight-forwards

*7.2.2.1.1 General:*

Tight-forward play consists mostly out of rucks, mauls, line-outs, scrums, attacking and defensive duties (Craven, 1974; Van Gent, 2003). The tight-forward's role in rugby is to keep and secure possession of the ball (Hare 1997, in Van Gent, 2003).

The important components of tight-forwards are that they have the correct body build and length, that they are strong, and that they must have speed and high endurance (Craven, 1974; Hazeldine & McNab, 1991; Pool, 1997; Van Gent, 2003).

Feedback:

- The specific roles of the tight-forwards with regards to skills such as cleaning and rucking vary considerably between the different positions. These roles are also determined by the overall game-plan and specific pattern that the team adopts. Rugby has changed, traditional roles cannot be rigidly assigned or applied and general statements cannot be made (AE/PT).
- Line-outs are twice more likely to occur as what scrums are and therefore line-outs are crucial. A greater emphasis is now placed on tackling and rucking as opposed to what was encountered in the past (NM).

- Body types are important and tight-forwards need to control the tight phases (JW).
- Size (mass and length) is important for locks (PdV).

*7.2.2.1.2 Physical-motor:*

Feedback:

- Agility and quickness and strength are needed for success (EE).
- Multilateral movability is emphasised. Explosive strength, power, speed, endurance and acceleration are important (AE/PT).
- Props need a good "shoulder." The loose-head prop must have a strong right shoulder whereas the tight-head prop must have a strong right and left shoulder. The props must be athletic and the hooker must be mobile (JW).
- Agility and explosive power are needed for success. Locks must be mobile in rucks and mauls (PdV).
- Mobility, size and athletic ability are important (NM).

*7.2.2.1.3 Position and game-specific skills:*

Feedback:

- Overall ball skills are necessary for all positions. Props as scrum stabilisers and hookers that scrum well are noted. Hookers need to be good defenders. Locks as ball carriers and as cleaners of rucks are noted (EE).
- Good handling skills are required for all positions. More specifically, the ability of locks along the ground and in the air is important, along with the specialist position of the hooker (AE/PT).
- Control of the tight phases, in-contact skills and ball retention are important. Furthermore, the role of the modern prop has changed and they (actually all positions) therefore need to be "multi-skilled" and able in many facets of the game. They must all possess proper rugby-skills such as passing and kicking. The hooker can be seen as both a fourth loose-forward and/or a third prop and is also viewed as the organiser of the defence. For the locks, movement along the ground and reaction in the air are important (JW).

- The hooker is seen as the "third prop" and the organiser of the defence and must scrum well (PdV).
- Passing ability is important. Hookers assist props in scrummaging; the scrum will not be successful if this arrangement is faulty. Hookers also need "loose-forward" type skills. Props need to assist in the line-outs and need speed and explosive power. Locks are primary ball carriers (NM).
- Generic skills are needed both on attack and defence (RD).

*7.2.2.1.4 Psychological, vision, anticipation and reading of the game:*

Feedback:

- Mental capabilities, game intelligence and confidence are critical to line-outs, scrums, rucks and general play. Further, skills such as anticipation, decision-making and knowledge of the game are all vital (EE).
- They must all be good communicators. The different positions require a different psychological make-up: consider the mental requirements of the tight-head vs. loose-head vs. hooker. Knowledge of the game is a pre-requisite. They all need mental strength (JW).
- A strong character, along with organisational ability and leadership is needed. Good vision for the hooker is a requirement (PdV).
- Decision-making and a competitive attitude are important. The tight forwards cannot give in since a large proportion of the required skills and competition (i.e.: scrums) is face-to-face with the opponent. Game intelligence is important since lineout defence is "brain intensive" (NM).
- Decision-making based on awareness and on the reality of the moment as opposed to pre-conceived ideas is regarded as the ideal (RD).

### 7.2.2.2 Loose forwards

*7.2.2.2.1 General:*

Loose-forwards generally operate in tandem or in combination. They keep the ball in play and secure possession from the opponents. Skill, speed and strength are needed by loose-forwards (Pool, 1997; Van Gent, 2003). They are quick over short distances and are effective in defence. They have a height advantage over the front rowers but are shorter than the locks. In loose play they are tasked with securing and keeping possession of the ball of (Quarrie, *et al.,* 1996; Van Gent, 2003).

Van Gent (2003) says that to be effective in these roles they require mobility, power, endurance and acceleration in open play. They require power and strength to participate in the rucks, mauls and scrums as well as for effective defence (Nicholas, 1997 in Van Gent, 2003).

Feedback:

- Loose forward play is highly position-specific and each position (open-side, blind-side and eighth-man) all have very specific roles. They also need to possess good skills in the line-outs (NM).

*7.2.2.2.2 Physical-motor:*

Feedback:

- They require good fitness levels and must be quick (EE).
- Acceleration and quickness are requirements for these positions (AE/PT).
- Loose forwards must be tall and athletic, the fittest players on the field and must possess explosive power, acceleration and quickness (JW)
- Loose-forwards require explosive power (PdV).

*7.2.2.2.3 Position and game-specific skills:*

Feedback:

- They must possess "lightning fast" skills. Ball management at the base of the scrum is a requirement for eighth-men. Furthermore, loose forwards are involved in a great deal of cover defence and must keep ball in contact. Loose-forwards have very distinctive roles (EE).
- Reaction abilities are important (AE/PT).
- They require a ball-carrying ability and they must retain the ball in contact. Furthermore, they are involved in the line-outs, they must be good defenders

(including cover defence) and must be the "ball stealers." They link the forwards and the backs and must have good running lines. They also carry the ball over the advantage line. The eighth man must manage the ball at the base of the scrums (JW).

- They must maintain good running lines in support and in defence (PdV).
- Open-side flanks turn over ball on the ground and blind-side flanks carry the ball, clean out rucks and jump in line-outs. Eighth-men must always play forward and must be skilful and possess good defensive ability. Loose-forwards must be forward playing (NM).
- Generic skills needed on attack and defence (RD).

*7.2.2.2.4 Psychological, vision, anticipation and reading of the game:*

Feedback:

- They must have good anticipation ability and must also know when to go backwards or forwards or when to run and when to cover line. They need to possess good decision-making skills and must remain calm under pressure (EE).
- They must be good communicators and must be able to anticipate play and decide when to go forward or move backwards and when to cover lines. They are decision-makers and must remain calm under pressure (JW).
- They have to be good communicators, decision-makers and must be able to read the game (PdV).
- Mental endurance, courage, anticipation and game reading ability are critical for success in these positions (NM).
- Decision-making based on awareness and on the reality of the moment as opposed to pre-conceived ideas is regarded as the ideal (RD).

### 7.2.2.3 Backline players

Due to the large spread of positions that are incorporated within the backline, the focus will be on the generic factors that can most successfully be generalised throughout all the positions under consideration.

*7.2.2.3.1 General:*

The inside backs utilise the possession that is obtained by the forwards and they decide how this possession is used, i.e.: defensive or offensive moves (Van Gent, 2003). They need to be fast and able to accelerate away from the rucks, mauls, scrums and line-outs. Endurance is important for the positional play of these players, for the cover defence and for player support (Nicholas, 1997 in Van Gent, 2003).

The rest of the backline need speed and good ball handling skills and must know when and how to use both as needed (Van Gent, 2003). Their motor capacities, such as muscle endurance and aerobic capacity, are on the whole better than forwards (Babic *et al.,* 2001; Van Gent, 2003).

Feedback:

- The inside backs are the key link between forward and backline play and are the key decision makers of the team (NM).

*7.2.2.3.2 Physical-motor:*

Feedback:

- A strong inside centre is a necessity (EE).
- Multilateral movability once again emphasised (AE/PT).
- Speed is required on attack and defence (to take a half-gap). They also require agility, power and strength. Regarding positions 12 and 13; Jake White prefers the biggest player at no. 12 and the quickest player at no. 13. Jake White also states that often the full-back is one of the quickest athletes on the field (JW).
- Speed is most important and endurance is secondary, yet aerobic capacity is needed. Size is also of great importance to these players (NM).

*7.2.2.3.3 Position and game-specific skills:*

Feedback:

- They are required to be strong in defence and must break the first line of defence. Must also be able to accurately distribute the ball to either side and have good kicking skills. Role-specific nature of backline players is emphasised. The "second flyhalf" role of the fullback is questioned (EE).
- They require good handling skills while defence is usually conducted within the system that the team is playing in. The specialist goal kicking role of the flyhalf is also endorsed (AE/PT).
- Good ball distribution skills are needed to the left and right. They must be equally skilled with both hands and feet. They need to be good defenders. The wings and fullback must also be able to interchange with one another if the situation demands it. Also, you require a left-footed full-back if you have a right-footed flyhalf. No. 10 dictates the game and no. 12 creates opportunities. The striking force consists of 11, 13, 14, 15. The second flyhalf role of the fullback is questioned; the fullback is the anchor at the back and must be a good tactical kicker (JW).
- Centres must be strong and solid on defence. Often the wings organise defence from the outside and are required to determine where to strike from second phase or quick ball. Fullbacks need to be effective on the counter-attack (PdV).
- Good passing, kicking and handling skills are non-negotiable, as is solid defence. Furthermore, proper ball retention is of great importance. Wings must be courageous finishers and fearless is contact (NM).
- Generic skills are needed on attack and defence (RD).

*7.2.2.3.4 Psychological, vision, anticipation and reading of the game:*

Feedback:

- Positions 9, 10 and 12 are the technical decision makers and the creative force in the team. The flyhalf (no. 10) dictates the game with the inside centre (no. 12) performing a back-up role to the flyhalf. To fulfil this function, they require good vision and communication skills. Positions 11, 13, 14 and 15 are the striking force that needs to finish the moves and these positions require good anticipation and communication skills to enable them to effectively run into position (EE).

- Good leadership and knowledge of the game by flyhalf is required. They (and centres) must be able to perform under pressure (AE/PT).
- The inside backs are the decision-makers and the creative force in the team. Require good peripheral vision and communication skills as well as good anticipation skills (JW).
- Backline players require good vision and strong minds (PdV).
- Proper decision-making skills, communication skills, calmness under pressure and anticipation are all essential characteristics of backline players. It is important that not only do the backline players possess good rugby skills, but, that they also know when to use what skills under different circumstances. Backline players need to be courageous in finishing as well as in contact situations. The also need to be good defenders (NM).
- They need to be good communicators and this includes listening. A good game sense is also a prerequisite (RD).

#### 7.2.2.4 Discussion of findings

From the interviews conducted pre-, during and post-testing it can be seen that if anything, the approaches to talent identification in rugby originally pioneered by Pienaar, Spamer, Krüger and various colleagues are remarkably robust, accurate, applicable and still currently valid. While the morphological and physical-motor characteristics of the players may have changed over the years, the methods to test these characteristics have remained the same.

What these changes have necessitated, however, is the establishment of new norms and standards that adequately reflect these changes. In chapter three it was noted that over the last few decades there have been substantial changes in player physiques (Olds, 2001; Luger & Pook, 2004; Quarrie & Hopkins, 2007) with this further confirming the need for norms that accommodate and reflect these changes.

A rather significant aspect of these interviews is the role-specific nature of the positions. While some stated that generic skills are needed in all positions, the role-specific nature of these positions cannot be overlooked. Furthermore, in reviewing the rugby-specific skills testing the following can be said; while the tests of the afore-mentioned researchers are more than adequate, the need to develop further rugby-skills tests is a perhaps a further consideration, in keeping with the ever increasing trend toward the development and measurement of real-life representative tasks in talent identification as was noted in chapter six.

Attempts at this have been made and these attempts have been primarily guided and informed by the opinions expressed in the preceding interviews. The results of these attempts are discussed in the following section as well as in chapter eight of this study.

Finally, from the interviews the aspect of mental strength and toughness is raised. In chapter five the suggestion was made for the inclusion in talent identification protocols of the Elite Athlete Development Model of Cooper and Goodenough (2007) as a measuring instrument of the mental skills and approaches required for success. It can also be used as an instrument to monitor progression in the subsequent development of the athletes.

Rugby is *all about* mental (as well as physical) strength and toughness and this all-encompassing psychological and mental construct needs to be addressed as a matter of urgency. In the recent feedback received from the ARU, the measuring of mental toughness is already being implemented in their talent identification and development programs, showing that the inclusion of the Elite Athlete Development Model of Cooper and Goodenough (2007) into talent identification protocols and subsequent development initiatives in South Africa is not beyond the realm of possibility.

Also, vision, decision-making ability and the correct choice and execution of actions (perceptual-cognitive and perceptual-motor) were repeatedly emphasised by the interview subjects. As a result of this feedback, the Accuvision1000 test was successfully incorporated into the test protocol for this study.

The final test protocol that was used in test three of this study is fully described hereafter. The test protocols of tests one and two obviously preceded this final protocol used in test three, but with specific reference to the self-devised sport-specific tests, these were of a highly evolutionary nature. As a result, certain of the tests contained in these protocols were subsequently modified or discarded. These discarded tests have been described so as to indicate the evolution of this protocol. The physical-motor, anthropometrical and vision tests remained largely the same over the course of all three tests as can be seen in the following dicussion.

## 7.3 FINAL TESTING PROTOCOL

### 7.3.1 Background

Due to the evolutionary nature of the testing protocol that was utilised and modified for this testing procedure, only certain select tests were unchanged over all three protocols. These included the anthropometry and the physical-motor sections of the protocol.

#### 7.3.1.1 Anthropometry and physical-motor

A number of established tests were included in the anthropometrical and physical-motor sections of this protocol. The anthropometrical section of the testing protocol was reliable and it was able to conduct these tests as unchanged over all three testing opportunities.

Only one new and self-devised physical-motor test was successfully included and conducted over all three test protocols and this was the 3x5x22m Anaerobic

Capacity Test. It was also possible to establish norms for this test. The other attempt at a self-devised physical-motor test is the overhead push-press.

The overhead push-press was incorporated as a position-specific measure of the lifting strength of the props in the line-out. While this test holds promise and probably should be evaluated as a future consideration in testing, it was discarded due to concerns surrounding the functionality of the test as well as considerations surrounding the practicality of incorporating this specific type of test into this specific field testing protocol.

#### 7.3.1.2 Sport-specific skills

The sport-specific section of this protocol was divided into two categories, i.e.: core-skills (all positions) and position-specific skills. There are self-devised tests incorporated into both categories. The self-devised "S-Test" was incorporated into the core-skills section for all positions, as was a standard kick for distance test and the subsequently modified form of this test called the kick for distance and accuracy test. Further position-specific tests for backs included a kick for accuracy (quadrant) and a scrumhalf tyre pass. A position specific test for hookers called the Hooker throw-in test @ 6m, 8m and 10m was also included in the position-specific skills test section.

The results with the self-devised sport-specific tests can be regarded as being mixed at best, but still hold promise. One of the position-specific kicking tests was incorporated into the first test protocol but later discarded (kick for accuracy-quadrant), whereas the other test was modified to create another version, as noted earlier. The reasons for discarding these tests were for practical purposes as well as concerns regarding the relative difficulty and representativeness of these tests.

The kick for accuracy (quadrant) test was extremely difficult with only one successful kick performed by one of the subjects and it was therefore discarded. While difficulty with this test is a concern, this test could probably be further modified or used as a training exercise. The kick for distance test was successfully completed in the first two testing opportunities. The results are included in chapter eight. This test was then subsequently combined with an accuracy component with this new test conducted in protocol 3, test no. 3. There were varying results and these results are included in chapter eight.

The dynamic passing for accuracy S-Test also underwent an evolutionary process until the final and current form (protocol 3) was settled upon. As a result of the ongoing changes to this test, the total sample size for the final version of this test was very small, although certain baseline norms were established. Both the Scrumhalf tyre test and the Hooker throw-in test at 6m, 8m, 10m did not sufficiently test the skill of the individuals. Furthermore, the sample sizes were too low for norms to be established and these tests were also discarded. The Scrumhalf tyre test holds promise, however, and should be further investigated.

#### 7.3.1.3 Sport vision testing

A sport vision testing component was added to the testing protocol and this was successfully conducted in tests two and three. This test was conducted in the form of the "30 accurate lights in total time" option. The "120 accurate lights test" was conducted in test two but this was found to be extremely time consuming and therefore discarded, since it was felt that for field testing purposes this specific test version was unsuitable. Norms were successfully established for the "30 accurate lights in total time" test. Both these tests have been used successfully in previous studies such as Venter and Maré (2005) and du Toit *et al.* (2006b).

Therefore, what follows is a short description of the study population followed by the final test protocol of this study with the associated explanations. The discarded tests in each category have been included and briefly explained but *do not* form part of the final protocol for this study.

### 7.3.2 Sample group

The study population/sample group consisted of the following elite rugby squads: the Vodacom Cup squad (n=26) that consisted primarily out of Blue Bulls Vodacom Cup and U/21 Currie Cup players, the South African U/21 rugby squad (n=29) and the TUKS Rugby Academy squad (n=23). For the various achievements of these respective squads, please consult chapter one of this study.

In the total sample an accumulative percentage of 94.8% of all the participants were 21 and younger with the remainder ranging from 22 to 25 years of age. The Blue Bulls U/21 Currie Cup rugby squad was tested in January 2005 (Protocol 1, Test 1), the South African U/21 rugby squad was tested in April 2005 (Protocol 2, Test 2) and the TUKS Rugby Academy group were tested in October 2005 (Protocol 3, Test 3). Important to note that protocols 1 and 2 differed from one another and that protocol 3 is very similar to protocol 2.

### 7.3.3 Final test protocol

#### 7.3.3.1 Anthropometrical measurements:

**a) Tests included:**

- Body mass (Norton *et al.,* 1996; Van Gent, 2003).
- Height (Norton *et al.,* 1996; Van Gent, 2003).
- Skinfolds (4-sites)
    - Biceps, triceps, subscapular and suprailiac skinfolds (Durnin & Womersley, 1974; Hazeldine & McNab, 1991).

#### 7.3.3.2 Physical-motor measurements:

**a) Tests included:**

- Vertical jump (Harman *et al.,* 2000).
- 10/40m dash (Hazeldine & McNab, 1991).
- T-Test (Harman *et al.,* 2000).
- 3x5x22m Anaerobic Capacity Test (self-devised and modified from the "Ten x 22m shuttle run" test of Krüger *at al.,* 2001).

**b) Tests discarded: position-specific physical-motor tests**

- Overhead push-press/standing military press (Pearl & Moran, 1986).

**7.3.3.3 Rugby-specific self-devised skills tests:**

**a) Test included: core-skills**

- S-Test (self-devised and modified from the (1) "pass for accuracy over 4m" and (2) the "catching while moving forward" tests of Pienaar & Spamer, 1995 in Pienaar & Spamer, 1998).
- Combination Kick for distance and accuracy test (self-devised and modified from the "kick for distance" test of Pienaar & Spamer, 1995 in Pienaar & Spamer, 1998).

**b) Tests discarded: position-specific skills tests**

- Kick for accuracy (quadrant).
- Scrumhalf tyre pass test.
- Hooker throw in at 6m, 8m and 10m test.

**c) Tests modified:**

- Kick for distance test (Pienaar & Spamer, 1995 in Pienaar & Spamer, 1998).

**7.3.3.4 Sport vision tests:**

**a) Tests included:**

- The Accuvision1000 "30 accurate lights in total time" test (Venter & Maré, 2005; du Toit *et al.,* 2006b).

**b) Test discarded:**

- The Accuvision1000 "120 lights at a constant speed" test (du Toit *et al.,* 2006b).

**7.3.4 In-depth description of final test protocol**

This section includes a full description of the tests carried out for this study as well as the apparatus needed for these tests. All tests are performed by qualified Biokineticists or sport scientists. The final test protocol can be found in Appendix C.

#### 7.3.4.1 Anthropometric measurements

The anthropometric measurements were taken according to the procedures described by Norton *et al.* (1996) using a calibrated Harpenden calliper (Baty International, West Sussex, UK), with all the measurements taken on the right side of the body. The specific skinfolds selected are those recommended by Durnin and Womersley (1974) and Hazeldine and McNab (1991). These tests were conducted in all three protocols.

In keeping with the general approach incorporated in these test procedures, and as noted by Van Gent (2003), the tests are to be conducted with the subject standing in the anatomical position. Similarly, stature is taken with the head in the Frankfort-Plane, and therefore these concepts will be briefly described.

**1) The Anatomical position**

This is when the test subject is standing in an erect, upright position with their arms at their sides and with the palms of their hands facing forwards (Marfell-Jones, 1996; Van Gent, 2003).

**2) The Frankfort-Plane**

When measuring stature, the head needs to be in the Frankfort Plane. To achieve this Frankfort Plane, the lower edge of the eye socket, called the orbitale, needs to be in the same horizontal plane as the notch superior to the ear, called the tragion (Norton *et al.,* 1996; Van Gent, 2003).

**3) Vertex**

When the head is in the Frankfort Plane, the vertex is the most superior (highest) point that can be found on the skull (Norton *et al.,* 1996; Van Gent, 2003).

*7.3.4.1.1 Body mass*

*Aim:* To determine body mass (weight).

*Apparatus:* An electronic scale.

*Method:* The subject must be dressed in lightweight shorts. During the measuring, the athlete stands unsupported with their weight spread over both feet. The subject must look ahead and keep their head still. The body weight is measured to the nearest 0.1 (one tenth) of a kilogram (Norton *et al.,* 1996; Van Gent, 2003).

*7.3.4.1.2 Body stature (height)*

*Aim:* To measure stature (height).

*Apparatus:* Stadiometer.

*Method:* The subject must stand with their feet together and with the upper part of their back, as well as their buttocks and heels touching the stadiometer. The subject's head, when in the Frankfort plane, does not need to touch the stadiometer. The test measurer must keep their hands on the subject's jaw so that their fingers reach the mastoid process. The subject is then told to breathe in deeply and to hold this breath while the measurer gently applies an upward lift through the mastoid process, while keeping the head in the Frankfort Plane (Norton *et al.,* 1996; Van Gent, 2003).

The test recorder then firmly places the head board on the vertex of the subject's head, while pressing down as much of the subject's hair as is possible. The recorder must also assist in ensuring that the position of the head is kept in the Frankfort Plane and that the subject's feet do not come off the floor while measuring. This measurement is taken at the end of the deeply inhaled breath. Body stature measured to the nearest 0.1 (one tenth) of a centimetre (Norton *et al.,* 1996; Van Gent, 2003).

*7.3.4.1.3 Skinfold measurements*

*Aim:* To measure the skinfolds to determine body composition

*Apparatus:* Harpenden Skinfold Caliper (Baty International, West Sussex, UK) with a constant pressure of 10g/mm².

*Method:* The place where the skinfold is to be measured is clearly identified according to the anatomical landmarks and must be marked prior to the commencement of testing. A double layer of skin together with the subcutaneous adipose tissue must be grasped firmly between the thumb and the index finger. The measurer needs to be careful not to grasp any underlying muscle tissue. This measurement should be taken at the exact mark made prior to commencement (Norton *et al.,* 1996; Van Gent, 2003).

The mouth of the caliper is placed 1 cm lateral to the thumb and the index finger. The caliper is held at a right angle to the surface of the skinfold at all times. The trigger is released and the measurement is recorded two seconds thereafter to allow enough time for the skinfold to press firmly. This standard approach is necessary because adipose tissue is compressible. A complete measurement of all the skinfolds must be taken before repeating the process again. All skinfold measurements are taken to the nearest 0.2 (two-tenths) of a millimetre (Norton *et al.,* 1996; Van Gent, 2003). A further recommendation of Van Gent (2003) is that if there is a discrepancy of more than 1mm between these two test rounds, a third measurement must be taken.

The four skinfolds measured were those originally suggested by Durnin and Womersley (1974) and these are:

*1) Biceps skinfold*

This measurement is taken on the anterior surface of the subject's bicep, at the midway point between the anterior auxiliary fold and the antecubital fossa (Harpenden Skinfold Caliper, 2007).

*2) Triceps skinfold*

When performing this measurement, the subject's arm must be relaxed with the elbow extended. This measurement must be taken using a vertical skinfold on the posterior midline of the subject's upper arm, over the triceps muscle, at the halfway point between the bony process on top of the subject's shoulder (acrosion process) and the bony process on the subject's elbow (olecranon process) (Harpenden Skinfold Caliper, 2007).

*3) Subscapular skinfold*

This measurement is taken at the fold formed on the diagonal line extending from the vertebral border of the subject to between 1 and 2cm from the inferior angle of the subject's scapula (Harpenden Skinfold Caliper, 2007).

*4) Suprailiac skinfold*

This measurement is taken on the diagonal fold above the crest of the subject's ilium at the place where a line would extend down from the anterior auxiliary line above the hip bone and 2 to 3cm forward (Harpenden Skinfold Caliper, 2007). The suprailiac skinfold of Durnin and Womersley (1974) can be seen as being the same as the iliac crest skinfold (Norton *et al.,* 1996).

The sum of the four skinfolds is calculated and the body density can then be determined according to Durnin and Womersley's (1974) linear regression equation. The Siri equation (Siri, 1956 in Durnin & Womersley, 1974) is then used to convert this body density into a body fat % (Harpenden Skinfold Caliper, 2007).

The final comparative table for body fat % used by this study is included in table 7.1. This table contains the final product of the linear regression equation of Durnin and Womersley (1974) as well as the Siri equation (Siri, 1956 in Durnin & Womersley, 1974) mentioned in the previous paragraph.

The sum of the skinfolds is calculated and can then be compared to the age-group of the subject according to the table hereafter.

**Table 7.1: Body fat % versus skinfold thickness-male subjects (Harpenden Skinfold Caliper, 2007:npn)**

| Skinfold Thickness Sum | Age 17-19 | Age 20-29 | Age 30-39 | Age 40-49 | Age 50+ |
|---|---|---|---|---|---|
| | | | | | |
| 10mm | 0.41 | 0.04 | 5.05 | 3.30 | 2.63 |
| 12mm | 2.46 | 2.1 | 6.86 | 5.61 | 5.20 |
| 14mm | 4.21 | 3.85 | 8.40 | 7.58 | 7.39 |
| 16mm | 5.74 | 5.38 | 9.74 | 9.31 | 9.31 |
| 18mm | 7.10 | 6.74 | 10.93 | 10.84 | 11.02 |
| 20mm | 8.32 | 7.96 | 12.00 | 12.22 | 12.55 |
| 22mm | 9.43 | 9.07 | 12.98 | 13.47 | 13.95 |
| 24mm | 10.45 | 10.09 | 13.87 | 14.62 | 15.23 |
| 26mm | 11.39 | 11.03 | 14.69 | 15.68 | 16.42 |
| 28mm | 12.26 | 11.91 | 15.46 | 16.67 | 17.53 |
| 30mm | 13.07 | 12.73 | 16.17 | 17.60 | 18.56 |
| 32mm | 13.84 | 13.49 | 16.84 | 18.47 | 19.53 |
| 34mm | 14.56 | 14.22 | 17.47 | 19.28 | 20.44 |
| 36mm | 15.25 | 14.90 | 18.07 | 20.06 | 21.31 |
| 38mm | 15.89 | 15.55 | 18.63 | 20.79 | 22.13 |
| 40mm | 16.51 | 16.17 | 19.17 | 21.49 | 22.92 |
| 42mm | 17.10 | 16.76 | 19.69 | 22.16 | 23.66 |
| 44mm | 17.66 | 17.32 | 20.18 | 22.80 | 24.38 |
| 46mm | 18.20 | 17.86 | 20.65 | 23.41 | 25.06 |
| 48mm | 18.71 | 18.37 | 21.10 | 24.00 | 25.72 |
| 50mm | 19.21 | 18.87 | 21.53 | 24.56 | 26.35 |
| 52mm | 19.69 | 19.35 | 21.95 | 25.10 | 26.96 |
| 54mm | 20.15 | 19.81 | 22.35 | 25.63 | 27.55 |
| 56mm | 20.59 | 20.26 | 20.73 | 26.13 | 28.11 |
| 58mm | 21.02 | 20.69 | 23.11 | 26.62 | 28.66 |
| 60mm | 21.44 | 21.11 | 23.47 | 27.09 | 29.20 |
| 62mm | 21.84 | 21.51 | 23.82 | 27.55 | 29.71 |
| 64mm | 22.23 | 21.90 | 24.16 | 28.00 | 30.21 |
| 66mm | 22.61 | 22.28 | 24.49 | 28.43 | 30.70 |
| 68mm | 22.98 | 22.65 | 24.81 | 28.85 | 31.17 |
| 70mm | 23.34 | 23.01 | 25.13 | 29.26 | 31.63 |
| 72mm | 23.69 | 23.36 | 25.43 | 29.66 | 32.07 |
| 74mm | 24.03 | 23.70 | 25.73 | 30.04 | 32.51 |
| 76mm | 24.36 | 24.03 | 26.01 | 30.42 | 32.93 |
| 78mm | 24.68 | 24.36 | 26.30 | 30.79 | 33.35 |
| 80mm | 25.00 | 24.67 | 26.57 | 31.15 | 33.75 |

There are studies that have included this four skinfold method in their protocols. These include the studies of Gabbett (2005) on junior rugby league players, Gabbett (2006) on sub-elite rugby league players, Grant *et al.* (2003) in rugby union, Keogh *et al.* (2003) on regional and club female field hockey players and Krüger *et al.* (2001) on junior rugby union players.

#### 7.3.4.2 Physical-motor measurements

The following tests were performed to assess the physical-motor capacities of the subjects. After the anthropometrical measurements are taken the subjects are required to warm-up comprehensively and to stretch before commencing the physical-motor testing process. It is preferable that the warm-up and stretching is conducted by the fitness trainer or conditioner of the team. Failing this, the warm-up can be conducted by any of the qualified Biokineticists or sport scientists on the testing panel. These tests were conducted in all three protocols.

*7.3.4.2.1 Vertical jump*

*Aim:* To determine explosive power.

*Apparatus:* Chalk powder.

*Method:* The subject stands sideways to a wall or any flat surface and stretches their arm nearest to the wall above their head while keeping their feet flat on the floor. A mark is made with the chalk powder at the highest point of the subject's reach. The subject lowers their hand and from a crouched position (with flexed knees) jumps upward with an arm-swing as high as possible and touches the wall with their hand. Three attempts are allowed with the best score being the largest difference that is noted in cm (Harman *et al.,* 2000).

*7.3.4.2.2 10m/40m dash*

*Aim:* To determine acceleration and speed.

*Apparatus:* 50m measuring tape and 6 photocells.

*Method:* This test provides an indication of the accelerative ability as well as the speed of the subject. A 10 m and a 40 m distance are measured off with the tape measure. Photocells are placed at the starting line, the 10m point and the finishing line at 40m.

Once ready, the subject adopts a "ready" position behind the starting line with one or both hands on the ground. On the "go" command the subject sprints the 40 m at maximal speed. The subject is allowed 2 attempts with no less than five minutes (total) rest between these attempts. The time at the 10m as well as the 40m mark is recorded to the nearest 0.1 (one tenth) of a second, with the best attempt regarded as the best (lowest) time of the two attempts (Hazeldine & McNab, 1991).

As a precaution, it is recommended that two members of the test panel adopt positions at the 10m and the 40m mark as backup in the event of photocell failure. Fortunately, while this precaution was adopted during testing for this study, no cases of photocell failure were reported. It is recommended that the subjects use their rugby boots for this test if this test is performed on grass.

*7.3.4.2.3 T-Test*

*Aim:* To determine agility.

*Apparatus:* A 10m tape measure, four cones and a stopwatch.

*Method:* Set up the test according as shown in figure 7.1 hereafter. The subject starts at cone A. Upon the "go" command, the subject sprints 10m to cone B and touches the cone with their right hand. The subject then shuffles 5m to the left and touches cone C with their left hand. The subject then shuffles 10m to the right and touches cone D with their right hand. The subject must then shuffle 5m to the left and touches cone B with the left hand and then run/shuffle backward past cone A. Once past cone A, the test is over. Note: 1) when shuffling, the athlete should never cross their feet and always face front, and; 2) upon arriving at the cone, subjects must touch the base of the cone (Harman *et al.,* 2000).

Do note that while Harman *et al.* (2000) perform the test in yards, for the purposes of this study the test is performed in metres. The subject has two attempts with a minimum of five minute rest between attempts. The best attempt is considered to be the one with the lowest time. The time is measured to the nearest 0.1 (one tenth) of a second (Harman *et al.,* 2000). It is recommended that the subjects use their rugby boots for this test.

In their study investigating the T-Test as a measure of agility, leg power and leg speed, Pauole *et al.* (2000) compared the T-Test with some other speed and agility tests. They found it to be highly reliable in measuring a combination of components, including leg speed, leg power and agility. They recommended that the test be used to distinguish between those of high and low levels of sport participation. Therefore the T-Test is an excellent option for inclusion in talent identification protocols.

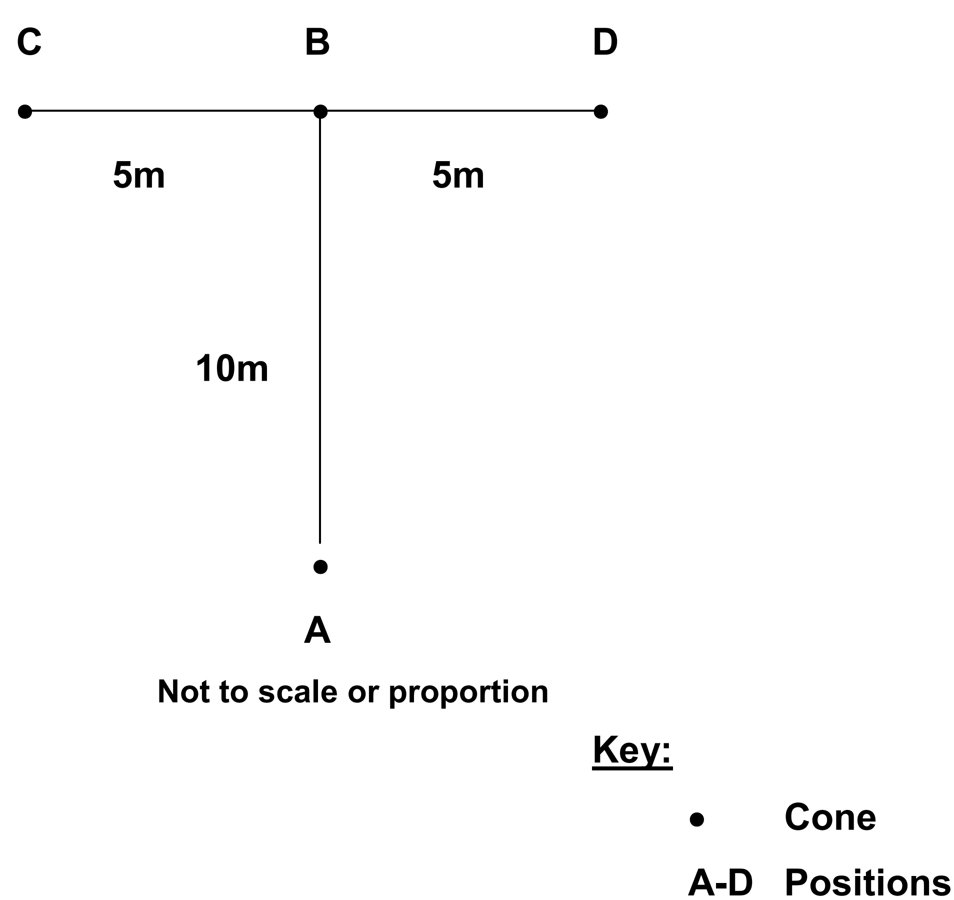


**Figure 7.1: Illustration of the T-Test for agility (Adapted from Harman *et al.,* 2000:298)**

*7.3.4.2.4 3x5x22m Anaerobic capacity test*

1) Background

This test has been adapted from the 10x22m shuttle run test done by Krüger *et al.* (2001:63-64) who say that *"Rugby is basically an anaerobic sport that consists of repetitive but short bursts of maximal activity. A player's anaerobic development can best be measured by a test requiring an all-out effort over a relatively short period of time. The distances covered by a rugby player during a rugby game are relatively short and fast. The ATP-PC and lactic acid energy systems (anaerobic metabolism) are, therefore, primarily used to deliver the necessary energy during the activity."*

In chapter four, the stop-start, high intensity nature of rugby was prominently noted (Quarrie & Wilson, 2000; Luger & Pook, 2004; Duthie, 2006). In fact, Duthie *et al.* (2003) state that bouts of high-intensity exertion in rugby are often followed by periods that do not allow for sufficient recovery, and that players need to be conditioned for the demands of short, high intensity efforts with short rest periods in between.

Conley (2000) further says that when training for activities at near maximum power lasting between fifteen and thirty seconds, a work-to-rest ratio of between 1:3 and 1:5 is needed for sufficient recovery. For aerobic events, a work-to-rest ratio of 1:1 and 1:3 is required for sufficient recovery. Since rugby is essentially an anaerobic activity in an aerobic time frame, the work-to-rest ratio of 1:3 was regarded as a departure point for this test. This was in keeping with the theory behind adapting this 10x22m test that the game of rugby is, as just noted, an *anaerobic activity* (stop-start sprints of varying intensities interspersed with short rest periods) that takes place over an *aerobic time span* of 80 minutes.

But, in recalling the opinion of Duthie *et al.* (2003) once again, i.e.: insufficient recovery between high intensity efforts and high intensity efforts with short rest periods, the assumption was made that an even smaller work-to-rest (i.e.: less rest between high intensity bouts) ratio must be adopted to accurately mimic the insufficient recovery experienced between bouts of high intensity activity in rugby. Deutsch *et al.* (1998) confirm that a low work-to-rest ratio in high intensity activity is insufficient for proper recovery, and this therefore further underscores the initial sentiments of Duthie *et al.* (2003), as well as the decision to include 30 second rest periods between the sprints of 5x22m. And, as will be seen in the results (chapter eight), the ratios fell between 21 sec (loose-forwards and backs) and 24 sec (tight-forwards) of work for thirty seconds rest, providing the desired smaller work-to-rest ratio.

Note: the specific 10x22m shuttle run test of Krüger *et al.* (2001) has also been used by the Department of Sport Sciences at the Tshwane University of Technology in Pretoria.

2) Test description
*Aim:* To determine anaerobic capacity in an aerobic time-frame
*Apparatus:* Stopwatch
*Method:* This test must be performed between the 22m and the try line of the rugby field. The test group must be split between into the following groupings: 1) tight-forwards incorporating props, locks, and hookers; 2) loose-forwards incorporating flanks and eighth men, and; 3) backline players incorporating the half backs, centres, wings and fullbacks.

Each subject requires a tester to accurately monitor them, since this test is essentially an individual test performed in a group setting. At the word "go" the subjects are required to perform their first set of 5x22m sprints as fast as possible with the time taken to complete these 5x22m sprints noted by the tester. When the subject gets to the try line they need to touch the line with their foot and repeat this when they get back to the 22m line and so on.

Upon completion of the first set of 5x22m sprints, the subject is allowed a 30 second rest strictly monitored by the tester before they commence with the second set of

5x22m sprints. Upon completion of this set they will be allowed one last 30 second break before being required to perform the last set of 5x22m sprints. This then concludes the test. Therefore there are 3 sets of 5x22m sprints and two sets of 30 seconds rest in between these sets. This test also serves to determine the relative decline in anaerobic performance of the different groupings. Average times for each grouping have been established. It is recommended that the subjects use their rugby boots for this test.

*7.3.4.2.5 Description of the discarded physical-motor test*

*1) Overhead push-press*

*Aim:* To determine the upper body strength of the lineout lifters (lifting in a lineout).

*Apparatus:* Barbell of weight 15/20kg with plates of differing weight and collars to keep plates in place.

*Method:* Also called the standing military press, in this test the subject stands with the barbell at chest height with hands shoulder width apart. The subject then presses bar overhead and lowers the barbell back to chest height (Pearl & Moran, 1986). It is important that a light warm-up set of ten repetitions is performed after which, in subsequent sets, the subject gradually increases the weight lifted while decreasing the repetitions. Rest periods incorporating stretching are to be conducted between sets. The 1RM of each subject is to be determined and noted.

*Reason for being discarded:* Concerns due to functionality and practicality of incorporating this test within field testing protocols. This test was initially included in protocol 1 but was removed prior to commencement of testing. This test does hold merit for determining the overall strength of rugby players however.

At the time of envisaged testing, no norms for this test could be found, although this does not preclude the fact that norms for this test do in fact exist. But, it was the intention of this study to establish norms for this specific test and sample group.

**7.3.4.3 Rugby-specific self-devised skills tests**

In this section, core and position specific skills tests were devised. The idea of designing core and position specific skills came from the approach adopted by the ARU in this regard. The results on all of these tests were mixed, although they certainly hold promise for future testing. The core skills will be described first, followed by the position-specific skills tests that were discarded.

*7.3.4.3.1 S-Test (core skills)*

*Aim:* To determine the passing ability to both sides while under pressure.

*Apparatus:* 2 Rugby balls, 5 cones, 2 targets, digital stopwatch.

*Method:* The starting point of this test is at cone A. This cone A is 5m away from cone set 1. Cone set 1 form a "gate" through which the subject has to run. The ball passer (P1) is positioned as illustrated in figure 7.2. Cone set 2 is positioned as illustrated. Target 1 (T1) is positioned as shown. Cone set 3 is positioned 5m away and directly in front of cone set 2, whereas cone set 4 is positioned as shown in the opposite corresponding position to cone set 1. Target 2 is also positioned as shown in the opposite corresponding position to T1 with the same applying to ball passer 2 (P2).

At the "go" command, the subject sprints at full speed from Cone A. As the subject reaches cone set 1 he receives the ball from the passer positioned as indicated. The subject has to pass through the "gate" for the test to be valid. After passing through the gate the subject then has to perform a swerving movement to the right toward cone set 2. After passing through the gate formed by cone set 2, the subject passes the ball torpedo style at the target 1 (T1).

The subject continues his run at full pace toward cone set three where once again he receives a ball from the passer (P2). After receiving the ball, the subject performs a swerve movement to the left and proceeds at full pace to cone set 4. After passing through the gate at cone set 4, the subject passes the ball at target 2 (T2) and the test is finished.

The subject has two attempts at this test with a minimum of five minutes rest between attempts. Five points are awarded per accurate pass with a maximum total of twenty points for this test. Since this test is timed, the ideal is to perform the test as accurately as possible in the least amount of time. The pass is regarded as accurate even if it hits or scrapes the outer perimeter of the target. The target is circular with a diameter of 50 cm and with the bottom perimeter of the circular target 1m off the ground. The passers (P1 and P2) can stand at any place on the course as long as it is not in the way of the subject and as long as the pass to the subject moves from the passer's position backwards to the subject who is moving forwards.

This test was modified from the "pass for accuracy over 4m" and the "catching while moving forward" tests of Pienaar and Spamer (1995) in Pienaar and Spamer (1998). One or both of these tests (in combination with other rugby-specific tests) have been subsequently used in Pienaar and Spamer (1996a; 1996b), Pienaar *et al.* (1998; 2000), Hare (1999), Booysen (2002), Van Gent (2003), Van Gent and Spamer (2005), Plotz and Spamer (2006) and Spamer and De la Port (2006).

A further and final note to make regarding the progression and evolution of this test is the following:

In protocol 1, this test was performed without being timed and with humans serving as targets. The scoring was also 3 points per accurate pass with the test first being performed to the left for five attempts and then to the right for five attempts and with these attempts to each side conducted separately. The limitations to this format were that the "live" targets were compensating for wayward passes and that the test took a very long time to complete. Therefore, the test was modified into its current form by combining the separate attempts to the left and right into one attempt for both sides and was included in test protocols 2 and 3 as illustrated above. The scoring was changed to five points per accurate pass and two attempts per subject and a time factor was added. Finally, the human targets were replaced with the targets described previously.

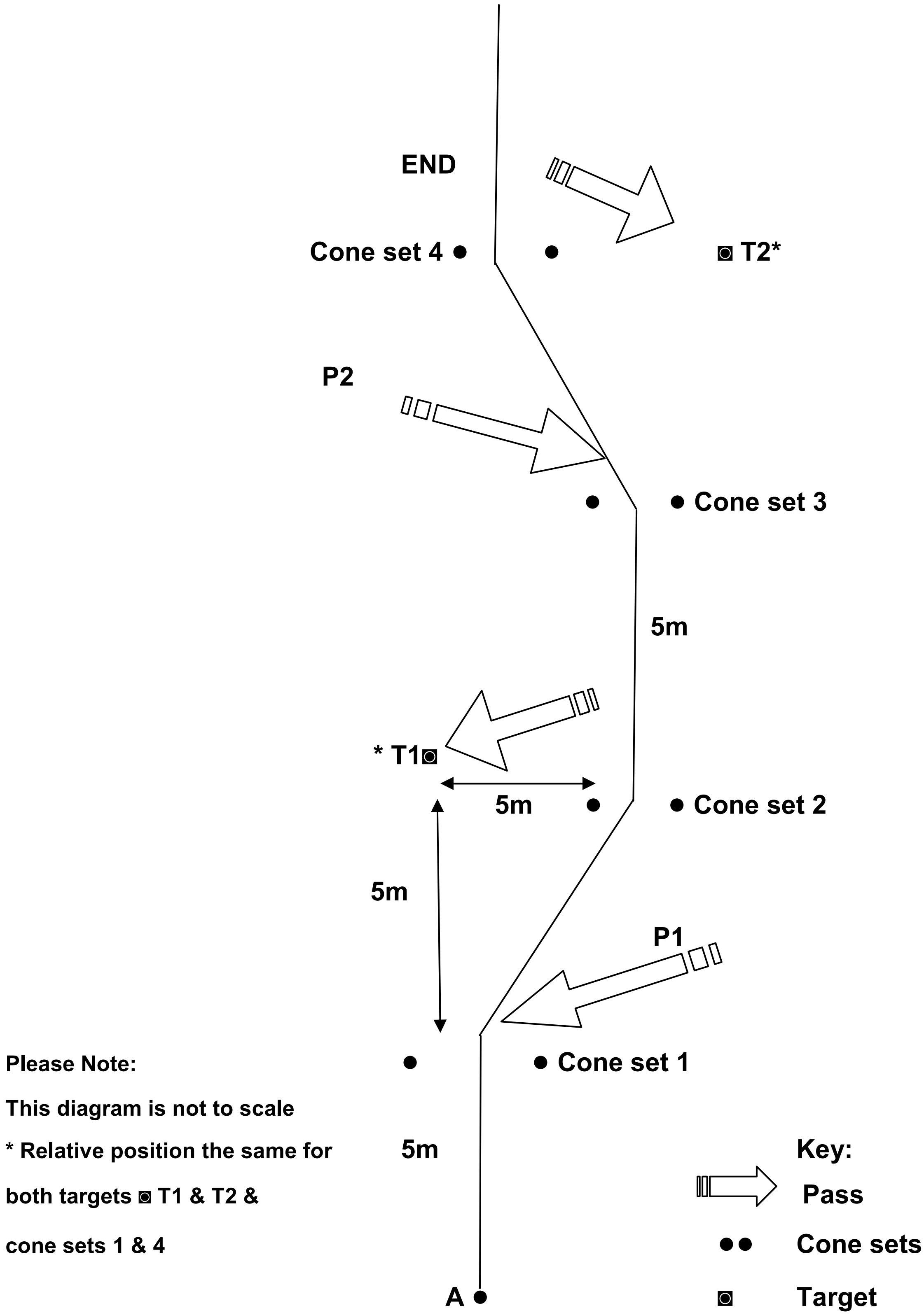


**Figure 7.2: Illustration of the S-Test for passing accuracy**

*7.3.4.3.2 Kick for distance and accuracy (core skills)*

*Aim:* To determine the ability to kick as far and as accurately as possible.

*Apparatus:* Rugby balls, 50m measuring tape.

*Method:* The area between the touchline and the 15m line of the rugby field is regarded as the valid zone. All kicks need to fall within this area for them to be certified as valid and to qualify for measurement. Any kicks that veer over either the touchline or the 15m are regarded as invalid and will not be measured.

The subject stands behind the try-line and may step on but not over this line for the kick to be valid. The subject is also permitted a run up before kicking. The subject must kick a torpedo kick as far as possible and if the kick is valid it will be measured. The subject gets two attempts with the left and two attempts with the right foot. The valid kick with the most distance for each foot (if applicable) is considered as the result.

This test was modified from the "kick for distance" test as pioneered by Pienaar and Spamer, 1995 in Pienaar and Spamer, 1998. This kick for distance test was subsequently used (in combination with other rugby-specific tests) in the studies of Pienaar and Spamer (1996a; 1996b), Pienaar *et al.* (1998; 2000), Hare (1999), Booysen (2002), Van Gent (2003), Van Gent and Spamer (2005), Plotz and Spamer (2006) and Spamer and De la Port (2006).

*7.3.4.3.3 Description of the discarded sport-specific skills tests*

*1) Kick for accuracy (quadrant)*

*Aim:* To test pin-point accuracy in kicking ability.

*Apparatus:* Plastic flag poles or cones, 4 rugby balls.

*Method:* The 22m area must be divided into 4 quadrants and marked as shown in figure 7.3 by plastic flagpoles or cones. The subject stands at the position marked KP. This position must be placed approximately halfway between the 10m and the 22m lines. The subject receives a ball passed to him from a distance of 5m from the front from a passer standing at the cone marked PP. The subject then has to either torpedo or “end-over-end” kick the ball to the quadrant that is called out by the tester as the ball is passed.

The subject receives four attempts per foot. Three points are awarded per accurate kick and no points are received for inaccurate kicks. The subject can therefore receive a maximum of 24 points for this test.

*Reason for being discarded:* This test was incredibly difficult to successfully complete with only one accurate attempt on both the right and the left feet out of a total of 7 and 8 subjects attempting this test respectively. It is strongly recommended as a training tool however. It was included in protocol 1 but discarded thereafter and not included in protocol 2.

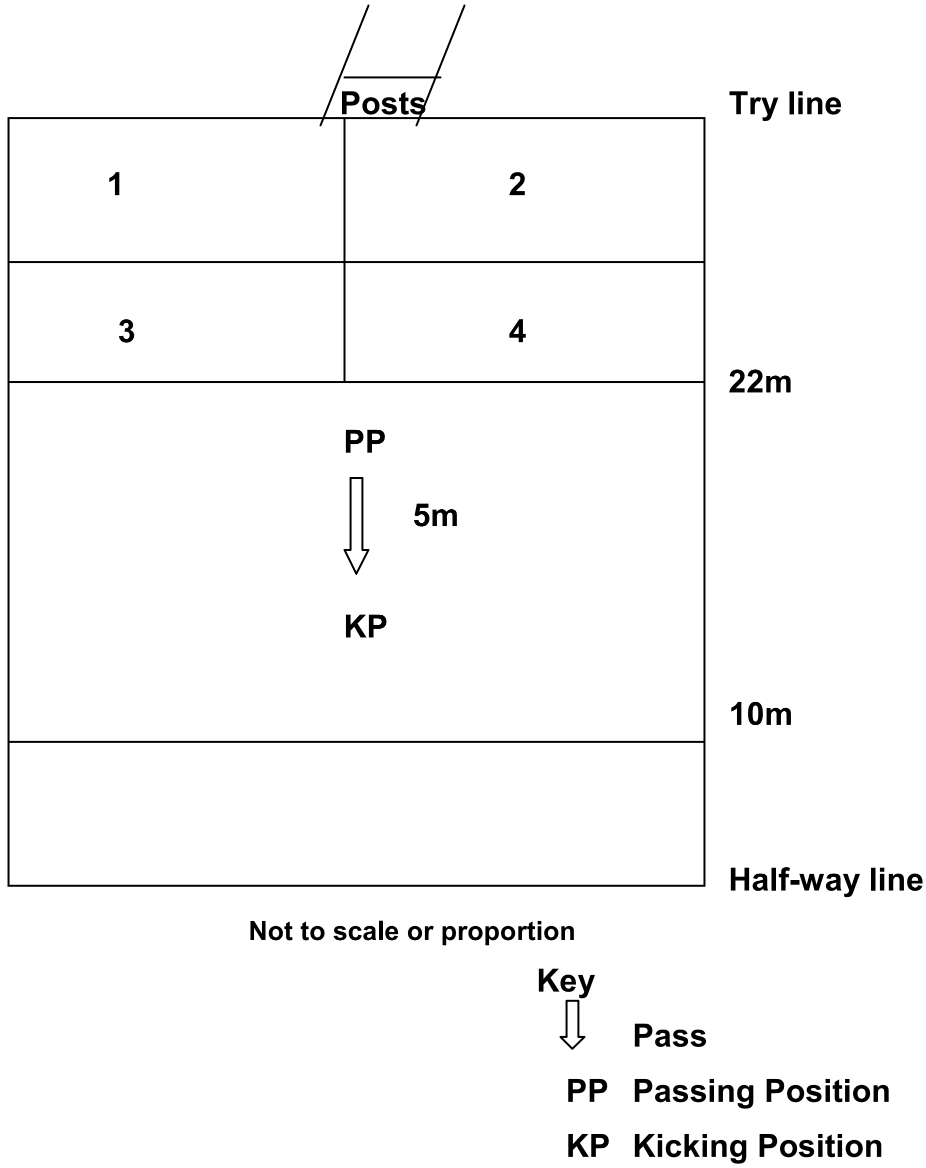


**Figure 7.3: Illustration of the kick for accuracy (quadrant) test**

*2) Scrumhalf tyre pass test*

*Aim:* To test the reactability and passing accuracy of the scrumhalf from a simulated "base of scrum" scenario.

*Apparatus:* 1 tyre, 1 rugby ball, 1 cone placed at the position indicated in the illustration below, 10m measuring tape, 1 stopwatch and 1 cone.

*Method:* The target T1 is placed at the position that corresponds with 5m behind and 5m to the side of the tyre. At the command "go" the scrumhalf runs from the starting point to the tyre. He must then "dig" or remove the rugby ball out of the tyre and pass a torpedo pass toward the target T1 as quickly and accurately as possible. This movement will be performed to the left and to the right and is a timed test.

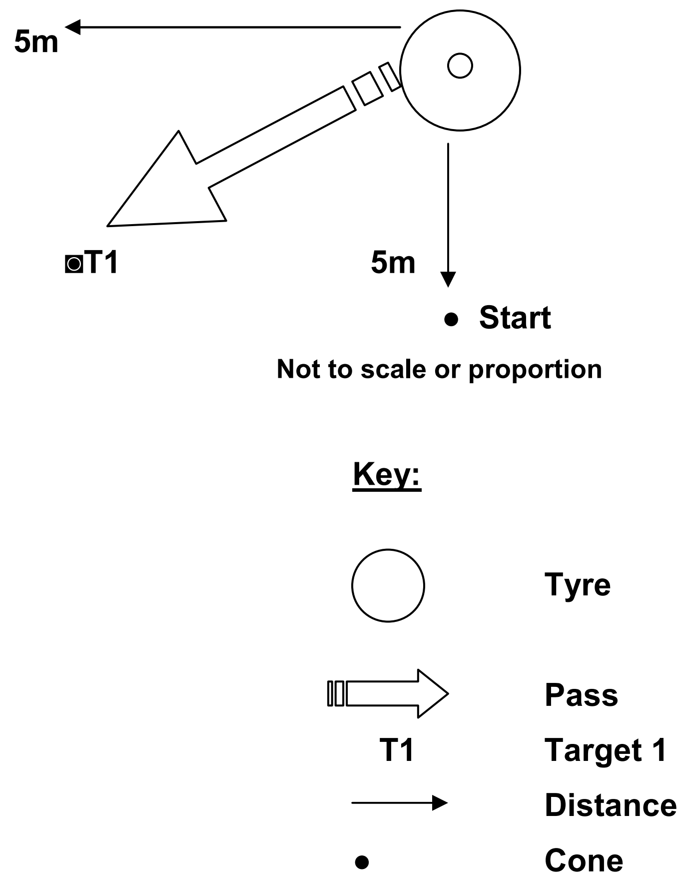


**Figure 7.4: Illustration of the scrumhalf tyre pass test**

Initially, in protocol 1 this test consisted of five attempts to each side and with 3 points awarded for every accurate pass. The maximum score for this test was 30 points in total. It was also not a timed test. Subsequently, in protocols 2 and 3 the number of attempts was decreased to 2 attempts to a side with each successful attempt receiving 5 points. The maximum score for this test is therefore 20 points in total. The test is also timed in protocols 2 and 3.

No points are awarded for inaccurate passes. The athlete can therefore receive a maximum of 30 points for this test. The pass is regarded as accurate even if it hits or scrapes the outer perimeter of the target. The target is circular with a diameter of 50 cm and with the bottom perimeter of the circular target 1m off the ground.

*Reason for being discarded:* This test was found to be too easy and the sample size for this group was too small to establish meaningful norms.

*3) Hooker throw in at 6m, 8m and 10m test*
*Aim:* To test the accuracy of the hooker throw in at the lineout.
*Apparatus:* Rugby ball, “lollypop” target and measuring tape.
*Method:* The hooker stands at the touchline with the “lollypop” target placed at 6m, 8m and 10m respectively. The target must be set at a height of 2.7m to 3.3m high. The lollypop target has a diameter of 50 cm. The hooker then throws the ball at the target. Two attempts at each distance are allowed with five points awarded for a successful attempt. This therefore means that a maximum of ten points per distance can be achieved. In protocol 1, five attempts were allowed per distance with a maximum of one point per successful throw. Therefore, a maximum of five points per distance could be achieved. Thereafter, in protocols 2 and 3 the scoring was changed to 2 attempts per distance at five points each with a maximum total of ten points per distance achievable.

*Reason for being discarded:* After reviewing the testing process it was decided that the test did not sufficiently place a real life, game-specific demand on the hookers. Furthermore, certain testing inconsistencies were encountered, i.e.: different tester holding the lollypop on different testing occasions causing a discrepancy in the final height of the lollypop. The scores were therefore unreliable and also had a very small sample size, as with the scrumhalf tyre pass test.

*7.3.4.3.4 Description of the modified sport-specific skills test*

*1) Kick for distance*

*Aim:* To determine the maximum kicking distance.

*Apparatus:* 50m measuring tape and Rugby ball.

*Method:* The subject takes the rugby ball with both hands and using first one foot and then the other kicks the ball forward as far as possible. The subject may make use of a small run-up. Three attempts with each foot may be made and the best attempt with each foot is recorded.

*Reason for modification:* In Pienaar and Spamer (1995) in Pienaar and Spamer (1998), this test was done with the dominant foot as opposed to both feet that were used in protocols one and two of this study. This modification and the further modifications of this test have been discussed prior. Statistical values were established for this test however (both feet) and these can be found in chapter eight.

**7.3.4.4) Sport vision testing**

*7.3.4.4.1 Accuvision 1000 "30 accurate lights in total time" test*

*Aim:* To test for proaction-reaction time.

*Apparatus:* The apparatus used in this test is an Accuvision1000 display board that is 90 cm in width and 130 cm in length. Making up this board are 120 red light emitting diodes (or LED's) that are touch-sensitive. In the top right hand corner of this board is a display provides a continuous indication of the number of correct responses and the selected speed of the current task/test (Venter & Maré, 2005; du Toit *et al,* 2006b).

*Method:* This test consists of 30 lights that flash randomly on the Accuvision1000 board. The aim of this test is to touch these lights as fast as possible. As soon as one light is touched then the next light illuminates. The subject is required to complete this test as fast as possible; therefore, the lower the score on this test, the better. The parameter under investigation in this test is proaction-reaction time, i.e.: the time or speed of motor-reactions after a sensory input has been provided (Venter & Maré, 2005; du Toit *et al,* 2006b).

Two trials are performed per subject, with this test conducted immediately after all other physical-motor and skills tests are concluded. This introduces an element of game-specific fatigue into this testing process, which can be regarded as being the normal circumstances under which rugby players need to function. This test was first included in protocol two and was successful, with norms established. This can be found in chapter eight. The best score of the two is regarded as the subject's score for this test

This test was included as a result of the feedback from the interviews with the elite rugby coaches where it was stated that vision and decision-making ability (perceptual-cognitive and perceptual-motor ability) go hand in hand. This issue was also discussed at length in chapter five.

*7.3.4.4.2 Description of the discarded sport vision test*

*1) Accuvision 1000 "120 lights at a constant speed" test*

*Aim:* To test for peripheral awareness, proaction-reaction and visual concentration

*Apparatus:* The apparatus used in this test is an Accuvision1000 display board that is 90 cm in width and 130 cm in length. Making up this board are 120 red light emitting diodes (or LED's) that are touch-sensitive. In the top right hand corner of this board is a display provides a continuous indication of the number of correct responses and the selected speed of the current task/test (du Toit *et al,* 2006b).

*Method:* In this test, 120 lights are flashed at a certain speed (speed 5 on the Accuvision). In the centre of the Accuvision1000 board is a green fixation light that randomly switches off and on. The subject is required to only touch the flashing lights if the central green fixation light is on with points deducted if the subject touches the flashing lights when the fixation light is off. Te final score is an indication of how many lights are touched while the fixation light is on, with the points subtracted for when the lights are touched when the fixation light was off. Therefore, in this case, a higher score is a better score (du Toit *et al,* 2006b).

Two trials are performed per subject with this test conducted immediately after all other testing was concluded. This introduces an element of game-specific fatigue into this testing process which is the normal circumstances under which rugby players must function. The best score of the two is regarded as the subject's score for this test

*Reason for being discarded:* It was not possible to perform this test with test group one, but in test group two it was found that this specific test was very time-consuming. Therefore this test was not included in protocol 3.

## 7.4 STATISTICAL METHODS

The information obtained from the sample group was captured onto computer and analysed by means of the Statistical Product and Service Solutions package. Since the sample size for this study is relatively small, non-parametric statistics were used to analyse the data. Non-parametric tests, also known as distribution-free tests, are a class of tests that do not rely on a parameter estimation and/or distribution assumptions (Howell, 1992).

The major advantage attributed to these tests is that they do not rely on any seriously restrictive assumptions concerning the shape of the sampled populations and thus accommodate small samples as is the case in this study.

### 7.4.1 The following statistical data analysis procedures were used:

#### 7.4.1.1 Descriptive statistics

Descriptive statistics are primarily aimed at describing data. The mean, standard deviation, minimum and maximum scores for each measurement per group were determined for reference purposes. This was also done for simulated data that will be discussed later on in this explanation.

#### 7.4.1.2 Inferential statistics

Inferential statistics test hypotheses about differences in populations on the basis of the measurements made on samples of subjects (Tabachnick & Fidell, 1996).

*7.4.1.2.1 Kruskal-Wallis One-Way Analysis of Variance:*

*"The Kruskal-Wallis one-way analysis of variance is a direct generalization of the Wilcoxon rank-sum test to the case in which we have three or more independent groups. As such, it is the distribution-free analogue of the one-way analysis of variance. It tests the hypothesis that all samples were drawn from identical populations"* (Howell, 1992:622). This test was used to determine significant differences between the various positions tested on all variables where norms need to be calculated. The positions were divided into three categories of players, namely tight-forwards, loose-forwards and backs.

**7.4.1.3 Norms**

In order to determine norms for each of the variables, stanine scores were determined. This procedure divides performance scores on all the variables measured into nine categories. These categories give an indication of the relative position of a score in the total population. Lyman (1963) in Smit (1986) provides the following explanation regarding stanines: stanines constitute a means of grouping scores or other measures into intervals or classes which are crude enough to permit use of a single digit to represent each class but precise enough for many practical and simple statistical purposes.

This analysis was only done where a variable was measured in the same way in all three measurements (protocols) of this study since this provided a big enough sample to base these norms on. Since the base size was very small per group of positions, truncated simulations were used to simulate a normal distribution of the variables on which the norms were determined. These simulations were done with Excel Simitar. Chapter eight discusses the conditions under which these simulations can and may be performed. All three these conditions were met. A full discussion of the results of this study can be found in chapter eight of this study.

# CHAPTER EIGHT

# RESULTS AND DISCUSSION

## 8.1 INTRODUCTION

The second main aim is to provide an alternative sport and position-specific testing protocol as well as comparative results consisting of norms and scores that will adequately identify and select those capable of participating in elite age-group rugby union. As shown in chapter seven, the protocol used in this study underwent some evolution to arrive at its final form. As would be expected when holding to a main aim of the type noted in the opening sentence of this chapter, a certain amount of experimentation is inevitable, and as a consequence the results obtained from experimentations such as the ones contained in this study cannot always be guaranteed.

More recent rugby related studies focused on the age groups closest represented by this study are those of Spamer and Winsley (2003b) on elite 18-year old South African and English rugby players, the studies of Van Gent (2003) and Van Gent and Spamer (2005) on the positional determinants of adolescent rugby players of various age-groups, Plotz and Spamer (2006) on talented 18-year old South African and English youth rugby players, and Spamer and De la Port (2006) who focused on U/16 and U/18 elite rugby players. In Van Gent (2003) and Van Gent and Spamer (2005) there was an U/19 sample group, but since only 5.2% and 27.3% of the sample in this study were 18 and 19 years of age respectively, comparisons with these studies are impossible.

It must be noted that the sample for this study was selected with a very specific purpose in mind. The overwhelming majority of the players in this sample are elite age-group players with 94.8% of the sample between the ages of eighteen and twenty one. Five point two percent of the sample range between 22 and 25 years old. Therefore, the results and norms determined in this study can be regarded as the best of the best and this protocol (with these associated norms) can therefore quite readily be used for the identification of the players who have the ability to play at "elite" age-group levels. This protocol and norms can even be used for selection purposes, with a specific aim at elite age-group rugby or as minimum requirements for senior elite teams.

With reference to the test protocol: with the anthropometrical, physical-motor and vision testing sections of this study, the results can be regarded as satisfactory with the intended aim achieved, i.e.: to establish norms of comparison for talent identification and selection purposes. On the sport-specific skills testing side, the results are satisfactory but need further elaboration. Since the overall sample sizes for the tests that were retained as well as discarded are small, this caution is justified. What these skills tests do serve to do, however, is to add to the already existing sport specific skills tests and further have potential for future utilisation and study. This will be discussed during the course of this chapter.

### 8.1.1 Statistical data analysis procedures:

The statistical data analysis procedures in this study were described in chapter seven and will not be discussed again.

### 8.1.2 Chapter outline

This chapter has been structured to include the statistical analyses in the following way:

*Section one: description of the sample by means of frequencies*

In this section the frequencies of the teams in the sample, the grouped positions, the general trends in age and the injury indications are provided.

*Section two: description of the variables that did not remain the same across measurements*

In this section, a description of those variables that were changed or discarded is included. Since the dicussion surrounding the reasons for dropping these variables has been conducted in chapter seven, only brief outlines and discussions of these variables are conducted in this section.

*Section three: results of non-parametric one-way analysis of variance to determine differences in measurements between different positions*
In this section, the results of the non-parametric one-way analysis of variance between the different positions are provided and discussed.

*Section four: norm tables of variables that were comparable over all measurements*
In this section, the simulated norm tables for this protocol are provided and discussed. This also incorporates the discussion surrounding the interpretation of the values pertaining to the S-Test.

*Section five: summary of findings*

## 8.2 DESCRIPTION OF THE SAMPLE BY MEANS OF FREQUENCIES

### 8.2.1 Data sampling

A sample can be defined as a subset of the population. A sampling plan can be described as a design, scheme of action or procedure that specifies how the participants are to be selected in a survey study (Rosnow & Rosenthal, 1996). The sample was drawn from rugby players of the following teams: the Blue Bulls Vodacom Cup squad consisting mainly of members of the Blue Bulls U/21 squad and some other players, the SA U/21 squad and the Tuks Rugby Academy squad.

A reminder of the note in chapter one regarding the Blue Bulls sample: the Blue Bulls Rugby Union aim to provide their age-group (U/21) players with the opportunity to play at Vodacom Cup level, and it is for this reason that almost the whole Vodacom Cup squad consisted of those who were part of the Blue Bulls U/21 Currie

Cup squad that participated in the U/21 Currie Cup competition in 2005. It is for this reason that the Blue Bull sample group is referred to as the Blue Bulls U/21 group, with the other, older players included in this sample group as well.

Before the data was analysed, data exploration was undertaken by looking at the frequency distribution and the shape of the distribution, means and standard deviations. This was done in order to identify outliers. Tabachnick and Fidell (1996) describe outliers as cases with such extreme values on one variable or a combination of variables that they distort the statistics.

Since these cases are not typical of the population and influence the distribution of data they were removed prior to the analysis. Two outliers were identified and removed. These were: 1) a case with a height of 164.5 cm and a weight of 70kg, and; 2) a case with a height of 186cm, a weight of 120,2kg and a 10m dash score of 2,9 seconds. The inclusion of these cases influenced the distribution of the variables affected in a negative way and was thus removed before further analysis commenced.

The results of this analysis are presented in tables 8.1 to 8.4.

**Table 8.1: Teams included in the study**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| **Valid** | Blue Bulls U/21 | 26 | 33.3 | 33.3 | 33.3 |
| | S.A. U/21 | 29 | 37.2 | 37.2 | 70.5 |
| | Tuks Rugby Academy | 23 | 29.5 | 29.5 | 100.0 |
| | Total | 78 | 100.0 | 100.0 | |

After the exclusion of the two outliers 78 cases remained for analysis. Each team measured represented approximately a third of the sample with the Blue Bulls U/21 making up 33% of the sample, the SA U/21 making up 37.2% of the sample and the Tuks Rugby Academy making up 29.5% of the sample (see table 8.1).

**Table 8.2: Grouped positions**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| **Valid** | Tight-Forwards | 21 | 26.9 | 26.9 | 26.9 |
| | Loose-Forwards | 27 | 34.6 | 34.6 | 61.5 |
| | Backs | 30 | 38.5 | 38.5 | 100.0 |
| | Total | 78 | 100.0 | 100.0 | |

As indicated earlier all the positions were grouped into three categories. Once again each category represented approximately a third of the sample with the tight-forwards making up 26.9%, the loose-forwards making up 34.6% of the sample and the backs making up 38.5% of the sample.

**Table 8.3: Age**

| | Frequency | Percent | Valid Percent | Cumulative Percent | |
|---|---|---|---|---|---|
| **Valid** | 18.00 | 4 | 5.2 | 5.2 | 5.2 |
| | 19.00 | 21 | 27.3 | 27.3 | 32.5 |
| | 20.00 | 35 | 45.5 | 45.5 | 77.9 |
| | 21.00 | 13 | 16.9 | 16.9 | 94.8 |
| | 22.00 | 1 | 1.3 | 1.3 | 96.1 |
| | 25.00 | 3 | 3.9 | 3.9 | 100.0 |
| | Total | 77 | 100.0 | 100.0 | |

The ages of players ranged between 18 and 25 years-old with almost half (45.5%) of the sample being 20 years of age. 27.3% of the sample were 19 years of age followed by 16.9% of the sample that were 21 years of age. Therefore, as stated earlier, the results from this study can most effectively be utilised for U/21 age-group rugby. And, considering that as of 2008 age-group rugby is moving toward the U/20 format, the results of this study can still be utilised since this study has a cumulative 77.9% of the respondents being 20 years of age and younger.

Due to the elite nature of the subjects in this study, injuries during testing were of prime concern. The concerns of the coaches, medical staff and management were borne out in this regard and enquiries into injury status were conducted. The results of this enquiry can be found in table 8.4. Depending on the type and nature of the injuries concerned, the subjects were carefully managed during testing with the overall bias being conservative in this regard.

As an example, a subject with a thumb injury would still do physical-motor tests but would not do passing tests. A subject with a knee injury would not perform the 10/40m dash or other tests requiring the use of the lower extremities, but this subject would still participate in anthropometrical testing.

The results in table 8.4 indicate that more than half (65.4%) of the players indicated that they did not have any injuries. The most common injuries encountered during testing were those of the knee (9%), the hamstring (6.4%) and the ankle (5.1%). The incidence of other injuries was much lower and these can also be found in table 8.4 hereafter.

**Table 8.4: Injuries indicated by players**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| **Valid** | None | 51 | 65.4 | 65.4 | 65.4 |
| | Hamstring | 5 | 6.4 | 6.4 | 71.8 |
| | Ankle | 4 | 5.1 | 5.1 | 76.9 |
| | Bicep | 1 | 1.3 | 1.3 | 78.2 |
| | Lower Back | 1 | 1.3 | 1.3 | 79.5 |
| | Groin | 1 | 1.3 | 1.3 | 80.8 |
| | Knee | 7 | 9.0 | 9.0 | 89.7 |
| | Shoulder | 2 | 2.6 | 2.6 | 92.3 |
| | Shoulder and Ankle | 2 | 2.6 | 2.6 | 94.9 |
| | Ribs | 1 | 1.3 | 1.3 | 96.2 |
| | Thumb | 1 | 1.3 | 1.3 | 97.4 |
| | Shoulder bone | 1 | 1.3 | 1.3 | 98.7 |
| | Foot | 1 | 1.3 | 1.3 | 100.0 |
| | Total | 78 | 100.0 | 100.0 | |

## 8.3 DESCRIPTIVE STATISTICS OF VARIABLES THAT DID NOT REMAIN THE SAME ACROSS MEASUREMENTS OR VARIABLES WITH SMALL BASE SIZES

Due to the evolutionary nature of this test protocol, there were a number of tests that were changed or discarded between protocols. The following tables indicate these tests and the scores that were attained for these tests. These scores have not been used in the determination of the norms of comparison for this study.

### 8.3.1 Protocol 1/Test 1: Blue Bulls U/21

The results indicated in Table 8.5 show that not all the subjects were measured on all the variables. Some of the measurements were demarcated for position specific testing, as they were for all three testing sessions and protocols.

The "Hooker throw in at 6m, 8m and 10m" was not completed by any of the players and therefore no descriptive statistics are available for this measurement. It is as a result of the inconsistencies in testing this variable over the three testing opportunities and protocols as well as the lack of adequately simulating as closely as possible the real-life game environment that this test has been removed from the final testing protocol for this study.

Furthermore, only 2 subjects completed the scrumhalf tyre pass test and the results should be interpreted with caution. In subsequent testing this test was once again found to be inadequate in simulating the real-life game environment. As a result of this fact, as well as the very small sample sizes, this test was discarded from the final testing protocol for this study.

The same caution applies to the backs (all) kick for accuracy (quadrant) test as there were only 8 and 7 players left and right respectively that attempted this test with only one accurate attempt per foot encountered.

**Table 8.5: Descriptive statistics for protocol one/test one-variables changed and with small base sizes (Blue Bulls U/21)**

| Test | n | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| S-Test total | 21 | 29.00 | 30.00 | 29.86 | 0.36 |
| Kick for distance (best attempt left) (m) | 19 | 29.00 | 66.00 | 45.32 | 9.32 |
| Kick for distance (best attempt right) (m) | 19 | 35.00 | 65.00 | 49.05 | 9.70 |
| Hooker throw in 6m (best attempt) | 0 | | | | |
| Hooker throw in 8m (best attempt) | 0 | | | | |
| Hooker throw in 10m (best attempt) | 0 | | | | |
| Backs all kick for accuracy (quadrant) (highest score left) | 8 | 3.00 | 3.00 | 3.00 | 0.00 |
| Backs all kick for accuracy (quadrant) (highest score right) | 7 | 3.00 | 3.00 | 3.00 | 0.00 |
| Scrumhalf tyre pass (highest score left) | 2 | 3.00 | 3.00 | 3.00 | 0.00 |
| Scrumhalf tyre pass (highest score right) | 2 | 3.00 | 3.00 | 3.00 | 0.00 |
| Valid n (listwise) | 0 | | | | |

The mean and standard deviations must thus be interpreted with caution since it is based on such small number of players. Due to the inherent difficulty in accurately performing this test, it was removed from the testing protocol for protocol 2 and thereafter, but, this test does serve as a challenging training exercise.

The S-Test was completed by 21 of the 26 players. A minimum score of 29 and a maximum score of 30 were obtained by these players with a mean score of 29.86. The standard deviation is very low at 0.36, indicating that there was very little variation in the scores obtained by these players. During the first measurement each player was granted 5 attempts to each side with a maximum score of 3 per successful attempt. These scores were added to get a total out of 30. The results thus indicate that most players achieved an almost perfect score for each leg. This high level of success can be attributed to the "live" targets that were used for protocol one and the fact that they compensated for bad passes by making an effort to retrieve these wayward passes. Changes were brought about for protocol 2 as described in chapter seven.

The scores from the altered S-Test as attained in protocols and tests 2 and 3 have been used to determine some form of discrimination in the performance of players during the norm phase of this statistical analysis. This will be presented near the end of this chapter.

Finally, note the highlighted scores for the kick for distance test that can be used for future reference purposes. The best attempts with the left foot ranged between 29 and 66 metres with a mean of 45.32 metres. The standard deviation is 9.32 metres. The best attempts with the right foot ranged between 35 and 65 metres with a mean of 49.05 metres. The standard deviation is 9.70. These scores can be used for future reference purposes. An important note in this regard is that Pienaar and Spamer (1995) in Pienaar and Spamer (1998) originally designed this test to be performed with the dominant foot as opposed to both feet that were used in protocols one and two of this study.

### 8.3.2 Protocol 2/Test 2: South Africa U/21

The results indicated in table 8.6 show that once again the base sizes were very small for the Scrumhalf tyre pass and the Hooker throw in tests, so as a consequence the results should be interpreted with caution. The base sizes ranged between 2 and 3 players who completed this test.

Almost all the players completed the kick for distance test. Their best attempts on the left side ranged between 0 and 52.30 metres with a mean of 23.76 metres. The standard deviation is fairly high at 15.01 indicating that the best efforts differed considerably within this team. The best attempts on the right hand side were considerably higher ranging between 16.30 metres and 55.60 metres with a mean of 31.34 metres. The standard deviation was still fairly high at 12.36 metres indicating that best efforts on the right hand side also differed significantly. These high standard deviations could be as a result of the dominant foot preference of the kickers required to kick with their non-dominant foot.

The mean scores of this group for the kick for distance test differ significantly from those attained in the Blue Bulls U/21 group. No explanation for this phenomenon is forthcoming and it is suggested that if this test and scores are used for future reference, that the Blue Bulls U/21 scores be the preferred option.

The Accuvision1000 (120 lights) test had a base size of eleven subjects with the maximum efforts ranging between 48 accurate lights and 84 accurate lights. The mean for this test was 73.18 accurate lights in the allocated time. This test was discarded due to the time factor associated with this test in a field-testing scenario, but this should not detract from the fact that this test can be used for future purposes in a laboratory setting.

**Table 8.6: Descriptive statistics for protocol two/test two-variables changed and with small base sizes (South Africa U/21)**

| Test | n | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Kick for distance (best attempt left) (m) | 29 | .00 | 52.30 | 23.76 | 15.01 |
| Kick for distance (best attempt right) (m) | 29 | 16.30 | 55.60 | 31.34 | 12.36 |
| Scrumhalf tyre pass (highest score left) | 2 | .00 | 5.00 | 2.50 | 3.54 |
| Scrumhalf tyre pass (lowest seconds left) | 2 | 3.410 | 3.560 | 3.485 | 0.106 |
| Scrumhalf tyre pass (highest score right) | 2 | .00 | 5.00 | 2.50 | 3.54 |
| Scrumhalf tyre pass (lowest seconds right) | 2 | 3.340 | 3.650 | 3.495 | 0.219 |
| Hooker throw in 6m (best attempt) | 3 | 0.00 | 5.00 | 3.33 | 2.88 |
| Hooker throw in 8m (best attempt) | 3 | 5.00 | 5.00 | 5.00 | 0.00 |
| Hooker throw in 10m (best attempt) | 3 | 5.00 | 5.00 | 5.00 | 0.00 |
| Accuvision1000 test (120 lights) (accurate lights) | 11 | 48.00 | 84.00 | 73.18 | 11.27 |
| Valid N (listwise) | 0 | | | | |

#### 8.3.3 Protocol 3/Test 3: TUKS Rugby Academy

Once again a very small number of individuals completed the Scrumhalf tyre pass and the Hooker throw in tests (see table 8.7). The base size for both tests consisted of 2 subjects each and these results should be interpreted with caution. These tests have been discarded for the final testing protocol for this study.

Ten and seventeen out of the 23 subjects in this squad completed the kick for distance and accuracy test on the left and right hand side respectively. The best attempts on the left side ranged between 20 and 50 metres with a mean of 32.65 metres. The standard deviation is fairly high at 8.00 indicating that the best efforts differed considerably within this team. Best attempts on the right hand side were considerably higher ranging between 25.10 metres and 47.50 metres with a mean of 39.76 metres. The standard deviation was fairly high at 6.24 metres indicating that best efforts on the right hand side also differed to a fairly high extent. Once again, a dominant foot preference most probably played a role in this regard.

No norms could be determined for these variables, including the kick for distance and accuracy test that was retained in the final test protocol, since they either had base sizes that were too small or the manner in which they were measured changed over time. The means, minimum and maximum scores can be used to a limited extent to get some indication of performance, but only on those variables were the base size was larger, as indicated in table 8.7.

The scores of the kick for distance and accuracy test have been highlighted for future reference and comparison. These were lower than the scores obtained on the kick for distance test and it is proposed that the added stress of the accuracy component could have led to more care being taken in scoring valid kicks.

**Table 8.7: Descriptive statistics for protocol three/test three-variables changed and with small base sizes (TUKS Rugby Academy)**

| Test | n | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Kick for distance and accuracy (best attempt left) (m) | 10 | 20.00 | 50.00 | 32.65 | 8.00 |
| Kick for distance and accuracy (best attempt right) (m) | 17 | 25.10 | 47.50 | 39.76 | 6.24 |
| Scrumhalf tyre pass (highest score left) | 2 | .00 | 5.00 | 2.50 | 3.54 |
| Scrumhalf tyre pass (lowest seconds left) | 2 | 3.86 | 3.92 | 3.890 | 0.042 |
| Scrumhalf Tyre Pass (highest score right) | 2 | 0.00 | 5.00 | 2.50 | 3.53 |
| Scrumhalf Tyre Pass (lowest seconds right) | 2 | 3.82 | 4.57 | 4.195 | 0.530 |
| Hooker throw in 6m (best attempt) | 2 | 5.00 | 5.00 | 5.00 | 0.00 |
| Hooker throw in 8m (best attempt) | 2 | 5.00 | 5.00 | 5.00 | 0.00 |
| Hooker throw in 10m (best attempt) | 2 | 5.00 | 5.00 | 5.00 | 0.00 |

## 8.4 NON-PARAMETRIC ONE-WAY ANALYSIS OF VARIANCE AMONGST DIFFERENT GROUPED POSITIONS

In order to establish whether different norms can be determined for the different grouped positions on the measurements with sufficient base sizes and that stayed consistent in measurement over all three tests, the Kruskall-Wallis One-Way analysis of variance test was performed to determine whether statistically significant differences existed between these various grouped positions.

Only variables that were on ratio scale level were included in this analysis. The S-Test was recoded to include the points achieved combined with the time taken to complete the test and to determine a total final value. This value was however on a nominal level and only categorized the achievable points for this test into 4 different categories. Therefore, the Kruskall-Wallis test could not be performed on this variable.

The variables that are included in this analysis are the following:

**1. Anthropometrical components:**

This includes height, body mass, biceps skinfold, triceps skinfold, suprailiac skinfold, subscapular skinfold, total of skin folds in millimetres and the body fat % versus skin fold thickness.

**2. Physical-motor components:**

This includes the vertical jump (all attempts), the 10/40 meter dash tests (all attempts), the T-Tests (all attempts) and 3x5x22m Anaerobic Capacity Test (all three measurements).

**3. Sport vision testing:**

This consists of the Accuvision 30 lights test.

The results of the Kruskall-Wallis tests and descriptive statistics per group per variable are presented in tables 8.8 to 8.15. The results of these analyses are also presented in graphic form in figures 8.1 to 8.5. The results of all analyses are presented in Appendix D of this study. The figures only contain the results of best attempts on all measurements that were applicable.

**Table 8.8: Results of Kruskall-Wallis Test on anthropometrical components**

| | Height (cm) | Body Mass (kg) | Biceps SF (mm) | Triceps SF (mm) | Suprailiac SF (mm) | Subscapular SF (mm) | Skin Total | Body Fat % vs. Skinfold Thickness |
|---|---|---|---|---|---|---|---|---|
| Chi-Square | 12.486 | 28.335 | 4.789 | 3.139 | 5.287 | 9.615 | 6.680 | 6.879 |
| Df | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Asymp. Sig. | **.002** | **.000** | **.091** | .208 | **.071** | **.008** | **.035** | **.032** |

**SF=Skinfold**

**Table 8.9: Descriptive statistics per group on anthropometrical components**

| Grouped Positions | | n | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| **Tight-Forwards** | Age | 21 | 18.00 | 21.00 | 19.71 | 0.78 |
| | Height (cm) | 21 | 171.50 | 202.00 | 184.96 | 8.29 |
| | Body Mass (kg) | 21 | 83.00 | 116.00 | 103.42 | 9.90 |
| | Biceps SF (mm) | 21 | 3.40 | 9.20 | 6.12 | 1.72 |
| | Triceps SF(mm) | 21 | 7.20 | 25.00 | 14.18 | 6.00 |
| | Suprailiac SF (mm) | 21 | 5.80 | 52.40 | 21.90 | 13.54 |
| | Subscapular SF(mm) | 21 | 7.60 | 27.20 | 16.20 | 6.14 |
| | Skin total | 21 | 27.20 | 104.00 | 58.40 | 24.83 |
| | Body Fat % vs. skin fold thickness | 21 | 11.91 | 25.00 | 19.44 | 4.63 |
| | Valid n (listwise) | 21 | | | | |
| **Loose-forwards** | Age | 27 | 18.00 | 21.00 | 20.07 | 0.73 |
| | Height (cm) | 27 | 170.00 | 194.00 | 182.55 | 6.14 |
| | Body Mass (kg) | 27 | 71.00 | 106.50 | 92.88 | 8.12 |
| | Biceps SF (mm) | 27 | 3.10 | 9.20 | 5.19 | 1.61 |
| | Triceps SF (mm) | 27 | 5.00 | 19.20 | 10.88 | 3.25 |
| | Suprailiac SF (mm) | 27 | 6.70 | 44.80 | 13.93 | 7.09 |
| | Subscapular SF(mm) | 26 | 7.00 | 18.40 | 11.42 | 2.70 |
| | Skin total | 26 | 25.30 | 83.60 | 41.07 | 11.88 |
| | Body Fat % vs. skin fold thickness | 26 | 11.03 | 24.67 | 16.08 | 3.01 |
| | Valid n (listwise) | 26 | | | | |

**SF=Skinfold**

**Table 8.9: continued**

| Grouped Positions | | n | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| **Backs** | Age | 30 | 18.00 | 25.00 | 20.17 | 1.86 |
| | Height (cm) | 30 | 171.00 | 193.00 | 177.77 | 6.35 |
| | Body Mass (kg) | 30 | 64.50 | 112.10 | 85.82 | 9.77 |
| | Biceps SF (mm) | 30 | 3.40 | 11.00 | 5.27 | 1.75 |
| | Triceps SF (mm) | 30 | 5.40 | 18.80 | 11.22 | 3.49 |
| | Suprailiac SF (mm) | 30 | 5.40 | 37.20 | 15.47 | 8.25 |
| | Subscapular SF(mm) | 30 | 5.80 | 21.00 | 11.34 | 3.20 |
| | Skin total | 30 | 23.40 | 88.00 | 43.29 | 15.22 |
| | Body Fat % vs. skin fold thickness | 30 | 10.09 | 25.00 | 16.61 | 3.89 |
| | Valid n (listwise) | 30 | | | | |

### 8.4.1 Anthropometrical components

Statistically significant differences were found between the height and body mass of the various positions. These statistical differences were statistically significant at the 5% level of significance. The height and body mass of the backs were significantly lower than those of the tight and loose-forwards, with the tight-forwards being both taller and heavier than the loose-forwards. The differences between these results can be seen in graphical form in figure 8.1.

It is indicated in result table 8.8 that there are statistically significant differences on all skinfold measurements except triceps skinfold. The total skinfolds in millimetres and the body fat % versus skinfold thickness as well as the subscapular skinfold show a significant difference at the 5% level of significance. The biceps and suprailiac skinfolds show significant differences at the 10% level of significance. These results are represented in graphical form in figure 8.2.

The results per variable measured and presented in table 8.9 can be interpreted as follows:

- The biceps skinfold score of the tight-forwards is significantly higher than the other two positions, with the loose-forwards having the lowest score.
- Even though the triceps skinfold score of the tight-forwards are higher than those of the other two positions, these differences are not statistically significant.
- The suprailiac scores of the tight-forwards are significantly higher than the score of the other two positions, with the loose-forwards having the lowest scores.
- The subscapular skinfold score of the tight-forwards is once again significantly higher than the other two positions with the backs having the lowest score.
- As could be expected, the skinfold total score of the tight-forwards is significantly higher than the other two positions with loose-forwards having the lowest scores.

- The body fat % score of tight-forwards is statistically significantly higher than the other two positions, with the loose-forwards having the lowest body fat%.

From these first anthropometrical tests, it can be that the loose-forwards outperform the tight-forwards and the backs in the body fat % (lowest %). They are then followed by the backs and then the tight-forwards. The tight-forwards outperform the loose-forwards and the backs in the body mass and body stature measures.

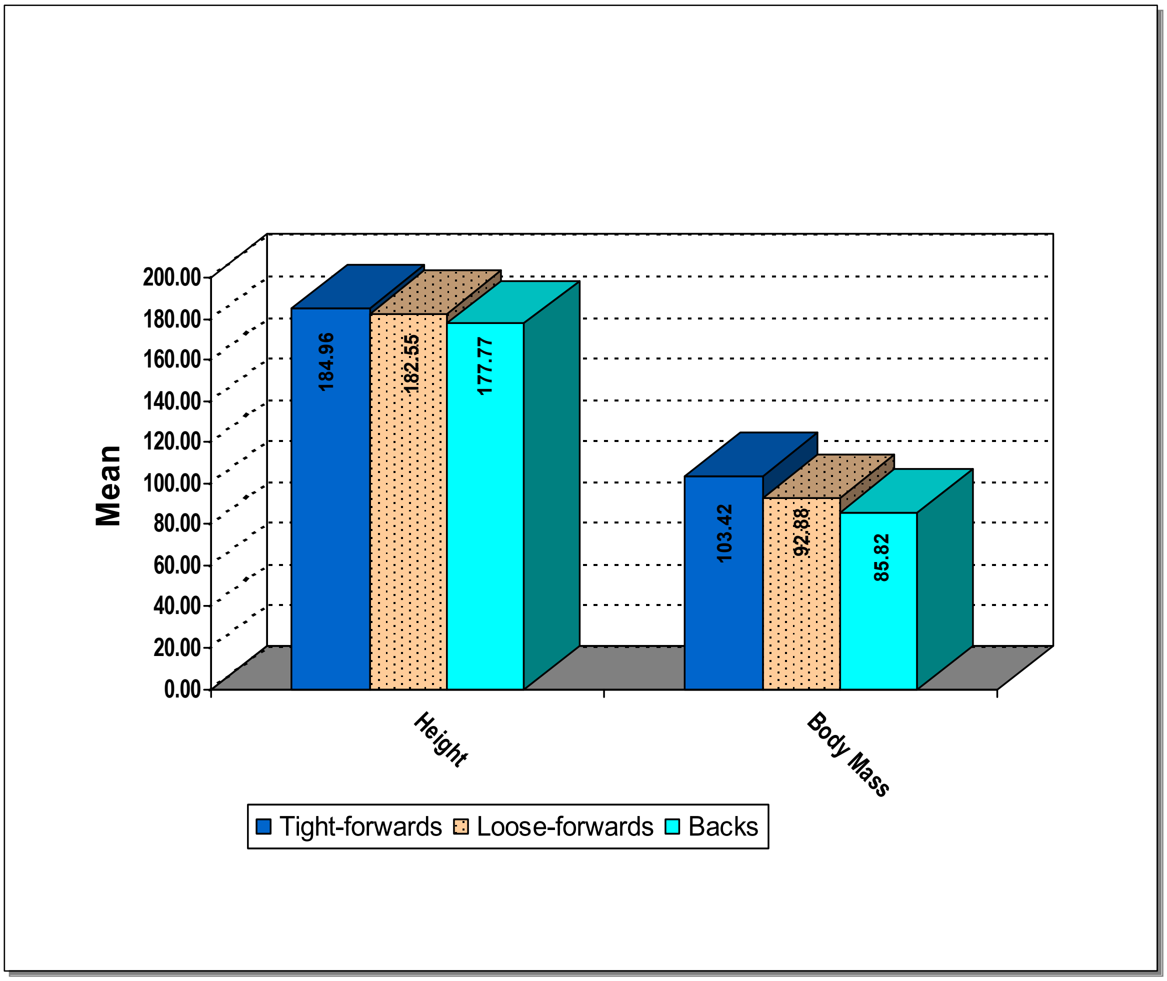


**Figure 8.1: Differences between positions on anthropometrical components**

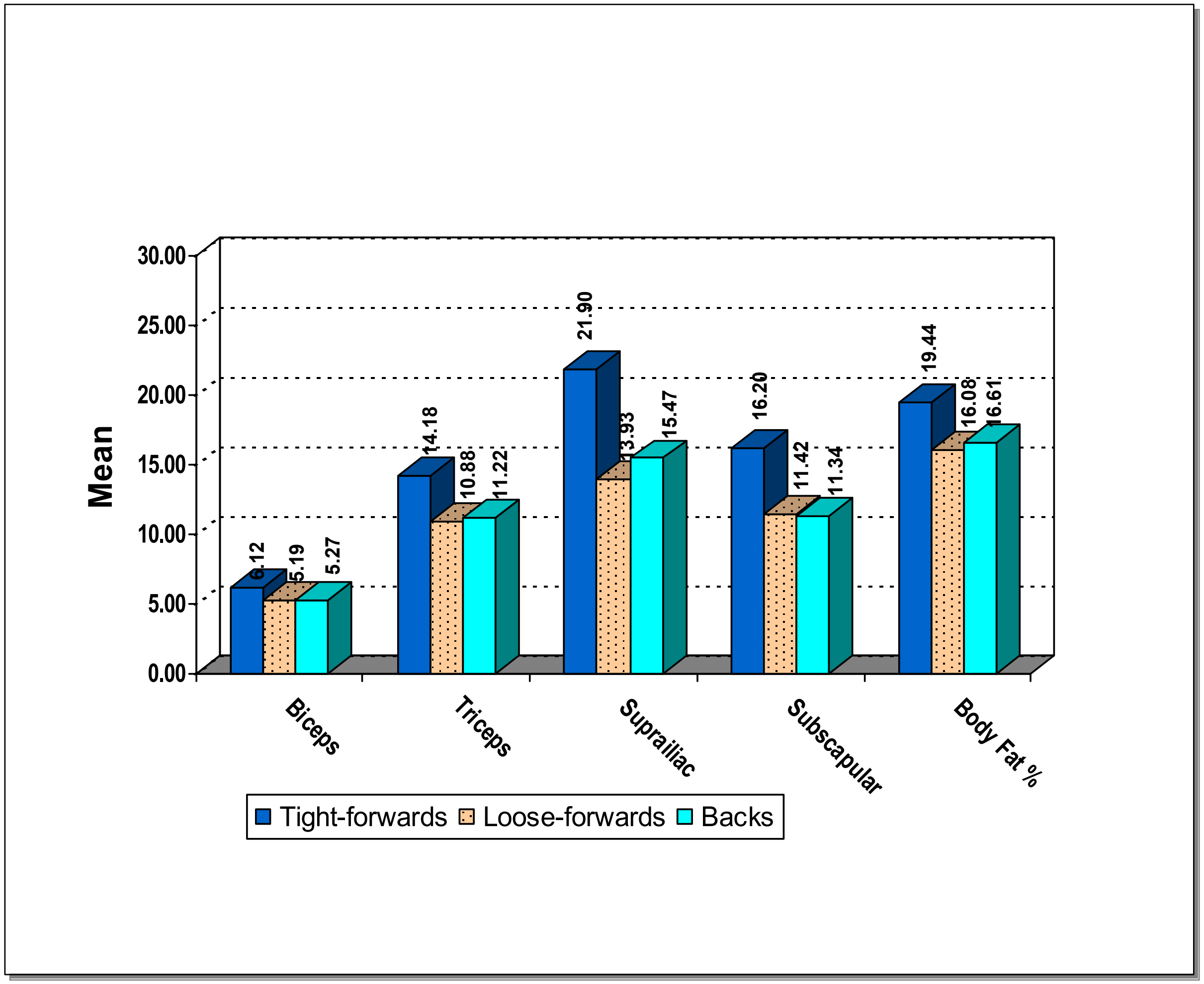


**Figure 8.2: Differences between positions on anthropometrical components**

**Table 8.10: Results of Kruskall-Wallis Test on physical-motor variables (best- effort)**

| | Vertical jump(cm) best effort | 10m Dash sec (10m) Lowest Score (sec) | 40m Dash sec (40m) lowest score (sec) | T-test lowest score |
|---|---|---|---|---|
| Chi-Square | .583 | **7.471** | **14.464** | **8.570** |
| df | 2 | **2** | **2** | **2** |
| Asymp. Sig. | .747 | **.024** | **.001** | **.014** |

**Table 8.11: Descriptive statistics per group on physical-motor variables (best effort)**

| **Grouped Positions** | | N | **Minimum** | **Maximum** | **Mean** | **Std. Deviation** |
|---|---|---|---|---|---|---|
| Tight-forwards | Vertical jump difference between reach distance and best attempt (cm) | 17 | 41.00 | 64.00 | 53.71 | 7.02 |
| | Valid n (listwise) | 17 | | | | |
| Loose-forwards | Vertical jump difference between reach distance and best attempt (cm) | 24 | 39.00 | 67.00 | 53.63 | 6.84 |
| | Valid n (listwise) | 24 | | | | |
| Backs | Vertical jump difference between reach distance and best attempt (cm) | 30 | 41.00 | 65.00 | 52.57 | 5.31 |
| | Valid n (listwise) | 30 | | | | |
| Tight-forwards | 10m dash sec lowest score (sec) | 16 | 1.82 | 2.35 | 2.161 | 0.177 |
| | 40m dash sec lowest score (sec) | 18 | 5.32 | 6.57 | 5.944 | 0.358 |
| | T-Test lowest score (sec) | 18 | 10.45 | 13.36 | 11.437 | 0.890 |
| | Valid n (listwise) | 13 | | | | |
| Loose-forwards | 10m dash sec lowest score (sec) | 20 | 1.69 | 2.44 | 2.012 | 0.196 |
| | 40m dash sec lowest score (sec) | 25 | 4.92 | 6.32 | 5.586 | 0.353 |
| | T-Test lowest score (sec) | 25 | 9.77 | 12.56 | 10.655 | 0.757 |
| | Valid n (listwise) | 18 | | | | |
| Backs | 10m dash sec lowest score (sec) | 25 | 1.75 | 2.39 | 2.006 | 0.173 |
| | 40m dash sec lowest score (sec) | 25 | 5.03 | 6.37 | 5.542 | 0.320 |
| | T-Test lowest score (sec) | 26 | 9.21 | 12.88 | 10.745 | 0.919 |
| | Valid n (listwise) | 16 | | | | |

### 8.4.2 Physical-motor components

The results in tables 8.10 and 8.11 can be interpreted as follows:

- There were no statistically significant differences on the vertical jump measures between positions even though, on the whole, the tight-forwards had higher scores than the other two positions. This finding could probably be attributed to the added power and strength requirements needed by the tight-forwards in the tight phases, most notably that of the scrums.
- A statistically significant difference was found between the positions on the 10 meter dash scores (lowest score). This difference was significant at the 5% level of significance. Backs and loose-forwards had significantly lower scores than the tight-forwards who had the highest scores. This implies that the backs completed the 10 meter dash in significantly shorter time, followed by the loose-forwards and the tight-forwards.
- A statistically significant difference was also found on the 40 meter dash (lowest score). This difference was significant at the 5% level of significance. In this instance, the backs once again had the lowest score followed by loose-forwards and tight-forwards who had the highest score. The tight-forwards thus completed the 40 meter dash at a significantly slower pace than the other two positions.
- A statistically significant difference was found on the best attempt on the T-Test. The lowest score indicates the shortest space of time in completing the test. The difference was significant on the 5% level of significance. The T-Test scores of the tight-forwards were significantly higher than the other two positions, indicating that it took them longer to complete this test. The loose-forwards had the best time, followed by the backs.

From the results it can be seen that the tight-forwards outperform the other positions in the vertical jump. The loose-forwards had the second best scores and the backs the worst scores in this test. The backs outperform the other positions in the 10m and 40m dash, with the loose-forwards having the second best scores and the tight-forwards having the worst scores. The loose-forwards outperform the other positions in the in the T-Test with the backs having the second best scores, and the tight-forwards the worst scores.

These results are represented graphically in figure 8.3 hereafter.

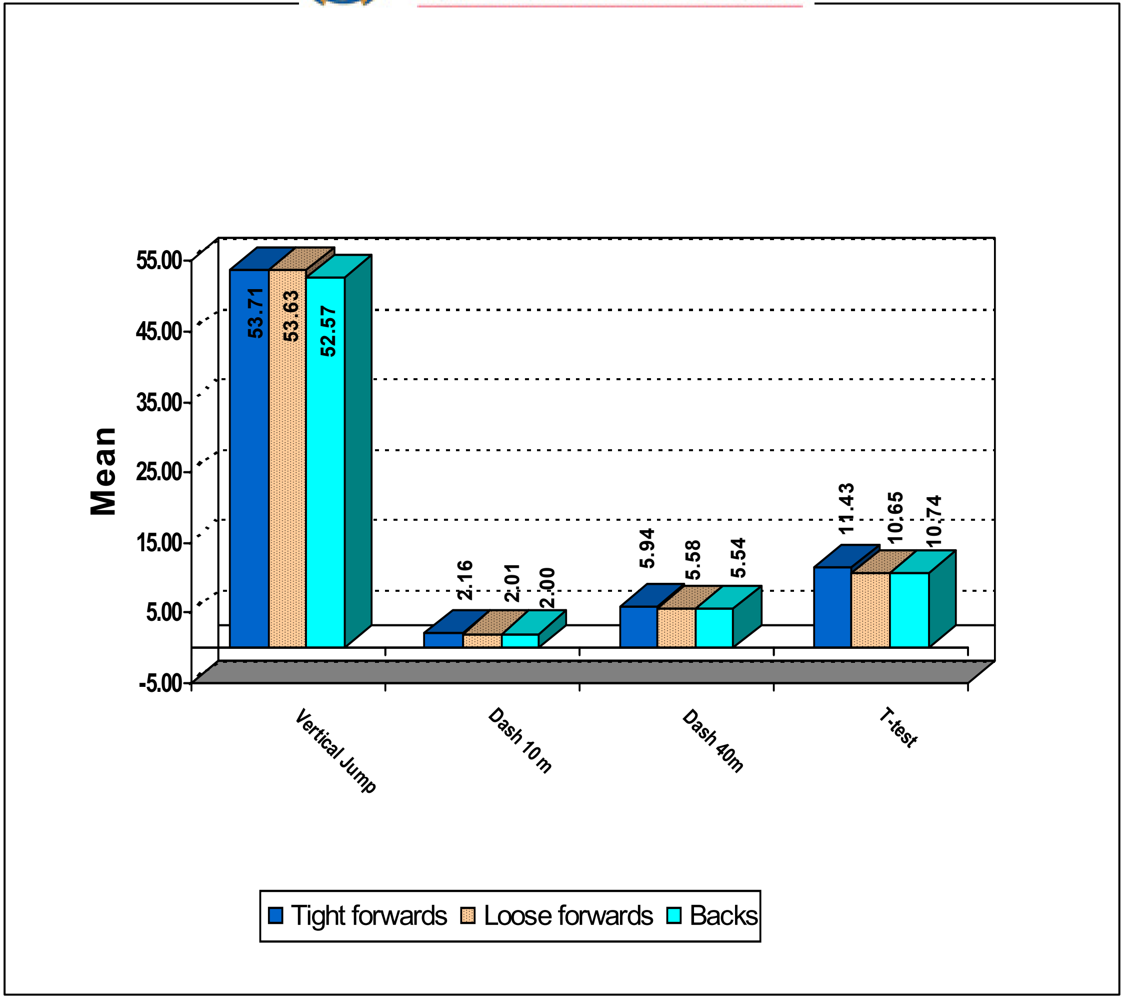


**Figure 8.3: Differences between positions on physical- motor components (only best efforts)**

**Table 8.12: Results of Kruskall-Wallis Tests on 3x5x22m Anaerobic Capacity Test**

| | **5x22m set 1 (sec)** | **5x22m set 2 (sec)** | **5x22m set 3 (sec)** |
|---|---|---|---|
| Chi-Square | 2.988 | 9.614 | 10.585 |
| Df | 2 | 2 | 2 |
| Asymp. Sig. | .224 | **.008** | **.005** |

**Table 8.13: Descriptive statistics per group on 3x5x22m Anaerobic Capacity Test**

| Grouped Positions | | n | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| Tight-forwards | 5x22m set 1 (sec) | 18 | 20.47 | 23.21 | 22.119 | 0.914 |
| | 5x22m set 2 (sec) | 18 | 21.16 | 27.10 | 23.869 | 1.499 |
| | 5x22m set 3 (sec) | 17 | 21.83 | 27.36 | 24.459 | 1.953 |
| | Valid n (listwise) | 13 | | | | |
| Loose-forwards | 5x22m set 1 (sec) | 25 | 19.72 | 23.70 | 21.533 | 1.015 |
| | 5x22m set 2 (sec) | 25 | 20.58 | 25.10 | 22.448 | 1.226 |
| | 5x22m set 3 (sec) | 22 | 19.90 | 24.98 | 22.543 | 1.305 |
| | Valid n (listwise) | 16 | | | | |
| Backs | 5x22m set 1 (sec) | 25 | 19.00 | 23.70 | 21.744 | 1.259 |
| | 5x22m set 2 (sec) | 25 | 19.96 | 27.84 | 22.837 | 1.699 |
| | 5x22m set 3 (sec) | 25 | 20.75 | 27.03 | 22.826 | 1.450 |
| | Valid n (listwise) | 15 | | | | |

The results in tables 8.12 and 8.13 indicate that no statistically significant differences were found between the scores of the three groups of positions on the first anaerobic capacity attempt. However, on the second and last attempt there were statistically significant differences at the 5% level of significance. In both the second and third attempt the scores of the tight-forwards were significantly higher than those of the other two positions. They thus took significantly longer to complete the test. The anaerobic capacity of the loose-forwards and backs remained fairly stable over the three measurements, but it was the tight-forwards that seemed to show a decrease in performance over time. The superiority of the loose-forwards in anaerobic capacity could probably be attributed to the relative workload that they produce to get through in the game. As can once again be seen, the loose-forwards outperform both the backs and the tight-forwards in this test as well.

These results are represented graphically in figure 8.4 hereafter.

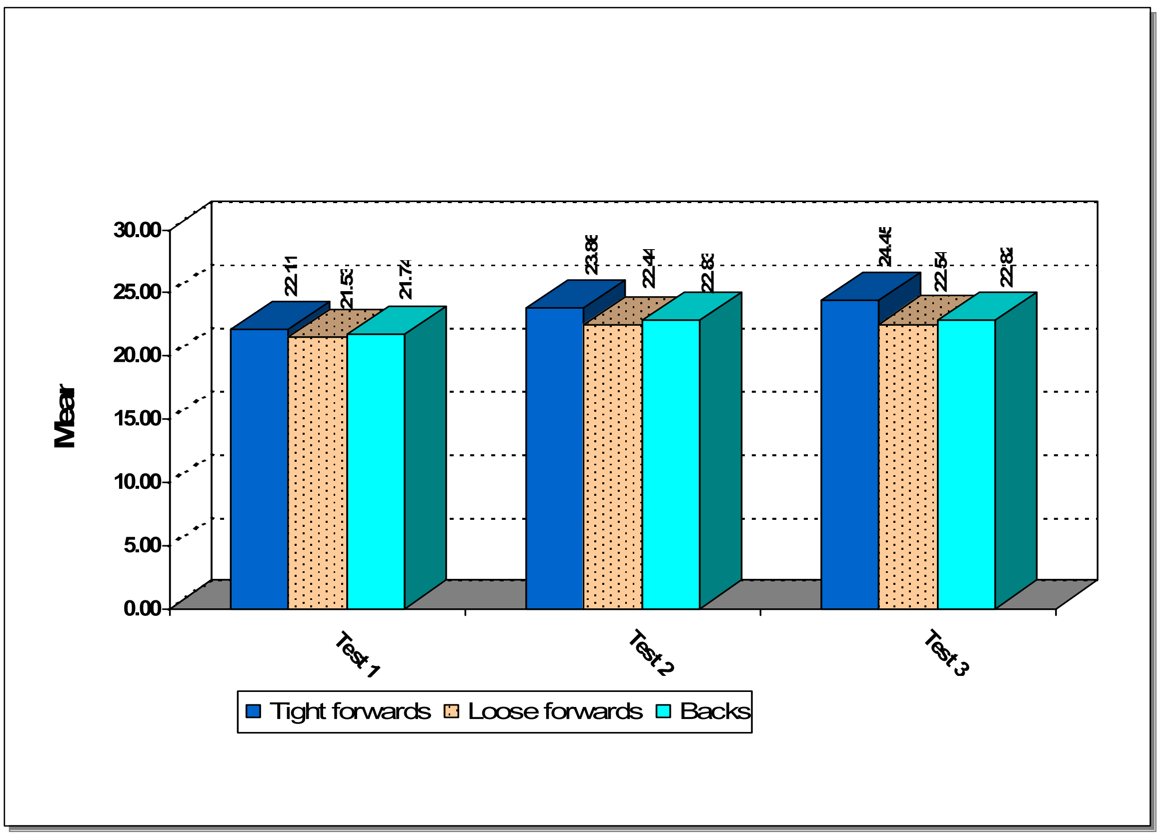


**Figure 8.4: Differences between positions on 3x5x22m Anaerobic Capacity Test**

**Table 8.14: Results of Kruskall-Wallis Test on Accuvision 1000 "30 accurate lights in fastest time test"**

| | Accuvision1000 Test (30 lights test) (sec) |
|---|---|
| Chi-Square | 4.119 |
| df | 2 |
| Asymp. Sig. | .127 |

**Table 8.15: Descriptive statistics per group on Accuvision1000 "30 accurate lights in fastest time test"**

| Grouped Positions | | n | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| Tight-forwards | 30 lights test (sec) | 15 | 19.00 | 29.00 | 24.333 | 3.331 |
| | Valid n (listwise) | 12 | | | | |
| Loose-forwards | 30 lights test (sec) | 18 | 18.00 | 28.00 | 21.778 | 3.474 |
| | Valid n (listwise) | 17 | | | | |
| Backs | 30 lights test (sec) | 18 | 17.00 | 29.00 | 22.778 | 4.387 |
| | Valid n (listwise) | 17 | | | | |

### 8.4.3 Sport vision testing

The results of the Accuvision1000 "30 accurate lights in fastest time" test are presented in tables 8.14 and 8.15. There were no statistically significant differences between positions even though the tight-forwards scored a worse time (longer time) in this test than the other two positions. The loose-forwards scored the best times (shorter time) in this test, followed once again by the backs and the tight-forwards.

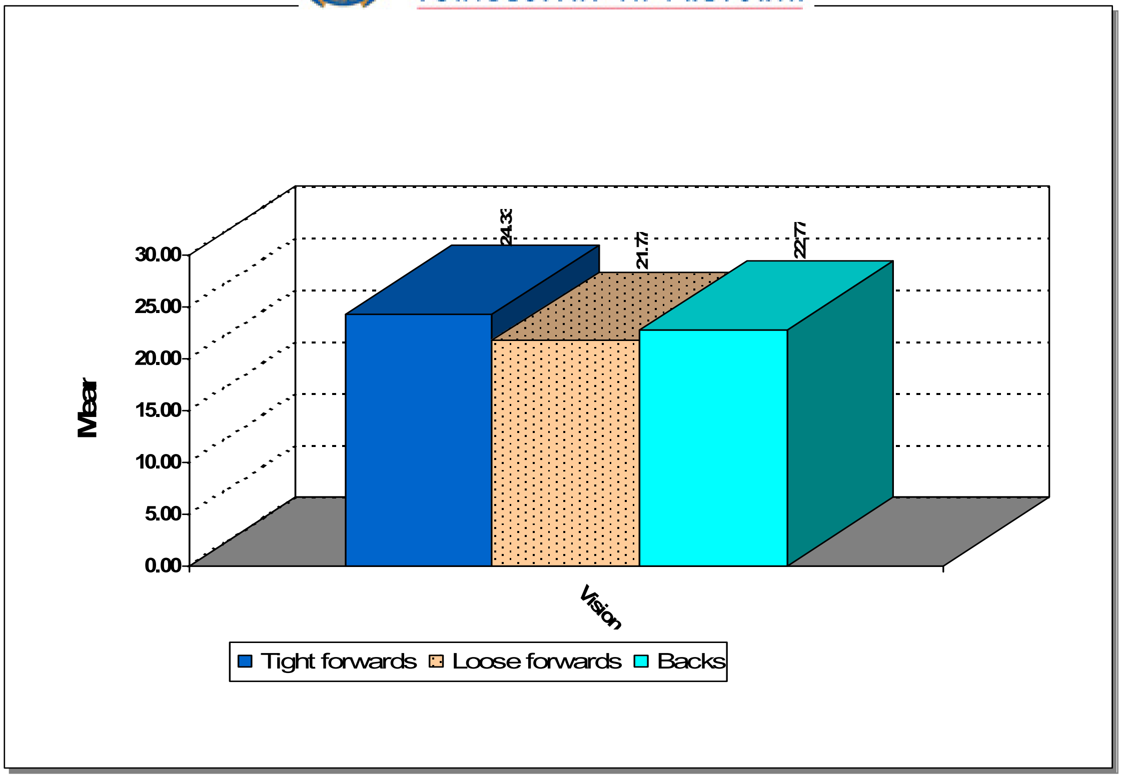


**Figure 8.5: Differences between positions on the Accuvision1000 "30 lights in fastest time" test (best efforts only)**

## 8.5 NORM TABLES OF COMPARABLE VARIABLES

Norms were determined for those variables that were comparable across the three measurements of the three protocols. There are certain conditions that need to be met in order to be able to calculate norms. These conditions are defined by Smit (1986) as follows:

a) The reliability of the normative scale is determined by the size and representativeness of the normative sample. In the case of this study, the normative sample is relatively small with some of the variables. Simulations were used to increase the sample size based on descriptive results of the original sample in order to simulate the normal distribution of scores.

b) Other information regarding the normative sample can add to the utilisation possibilities of the results. An example of this is the level of functioning; in this case it is elite age-group rugby players. Furthermore, in this study it can be assumed that due to the high level of sport participation that this study examines and measures, the performance on these variables needs to be at a corresponding high level and will thus not apply to the selection of lower level players such as school level participants. The application of these norms is therefore highly specific to elite age-group rugby.

c) A further consideration is the number of normative samples on which the norms are based.

Since the base sizes were relatively small on some of the variables and the assumption of the normal distribution of variables could not be assumed, truncated simulations were used. Base sizes were as little as 18 players completing some of the tests. The simulations were based on the mean, standard deviation, minimum and maximum scores of all the variables used over the three tests and protocols.

The function of the simulations was to simulate scores obtained on these variables as if they occurred in a much larger sample and to further simulate the normal distribution of these variables. The simulations were done by means of 250 iterations, thus simulating the results as if 250 individuals completed these tests. The means and standard deviations were compared to the original data in order to determine whether they were still representative of the sample used in this study. The means and standard deviations were found to be very comparable and these were therefore used to determine the norms on each variable. The norms were calculated separately for every positional grouping.

The means and standard deviations of the simulated data are provided in Appendix E.

As indicated earlier stanine scores were calculated for each variable. Performance scores on all the variables measured are divided into nine categories that will provide an indication of the relative position of a score in the total population.

According to Smit (1986) the scores obtained can be categorized as follows:

| | | |
|---|---|---|
| 1 | = | low performance |
| 2 & 3 | = | below average |
| 4.5 & 6 | = | average |
| 7 & 8 | = | above average |
| 9 | = | high performance |

For some variables a higher value constituted a better performance (for example vertical jump in centimetres) whereas in other variables a lower score represented better performance (for example time taken to complete a 10 meter dash). The variables in the tables to follow were grouped to include all those where a higher score is positive, in one table and those where a lower shore is positive in another table. This was done for practical considerations.

The stanine scores with their accompanying percentile rankings are indicated in each table with the raw score representing that table. Smit (1986) lists, amongst others, the following important advantages of stanine scales: 1) the equality of scale units are an advantage since the difference in performance of a stanine of 7 compared to 5 is just as significant as the difference between a stanine of 2 and of 4. The performance on various variables or tests thus reflects the relative intensity of performance accurately; 2) stanines almost automatically indicate an individual/subject's position relative to the normative sample, and; 3) stanines allow for the statistical manipulation of variables without sacrificing accuracy.

The only disadvantage to stanines is that it is an approximated scale with only 9 scale units. In the case of this study the score represented by the stanine scores are relatively close together and the practical application thereof should thus be investigated. It might be useful to look at the broader classification of low, below average, average, above average and high performance as indicators for selection purposes. The levels or categories of performance are indicated in different colours in the norm tables. Poorer performances are indicated in tones of red with higher performance in shades of blue, or, alternatively, the poorest performance is indicated in the darkest shade of grey, with the subsequent lighter shades indicating better performances.

The norms for tight-forwards are presented in tables 8.16 to 8.19, the norms for loose-forwards are presented in tables 8.20 to 8.23 and the norms for backs are presented in tables 8.24 to 8.27.

For the proper interpretation of these norm tables it is important to note to following: as stated earlier, a stanine of 9 is good and a stanine of 1 is bad but one needs to be careful how one interprets the stanine vs. percentiles. When it comes to body fat % (and speed, anaerobic endurance etc.) you want your body fat % score to be low, therefore it has a stanine of 9 (which is good), but, it has been assigned a percentile of 4 indicating that your fat % is only higher than 4% of the population and therefore, by implication it is lower than the remaining 96% of the population. When it comes to vertical jump in which you want your score to be as high as possible, however, your stanine is once again 9 but your percentile is 100% because your score is higher than 100% and therefore lower than 0% of the population.

**NORMS FOR TIGHT-FORWARDS**

**Table 8.16: Norms for tight-forwards on anthropometrical components**

| | Percentiles | Stanines | Biceps SF (mm) | Triceps SF (mm) | Suprailiac SF (mm) | Subscapular SF (mm) | Skin total | Body fat % vs. skinfold thickness |
|---|---|---|---|---|---|---|---|---|
| n | Valid | | 250 | 250 | 250 | 250 | 250 | **250** |
| Percentile | 4 | 9 | 3.83 | 8.08 | 7.97 | 8.83 | 31.18 | **13.01** |
| | 11 | 8 | 4.37 | 9.40 | 11.06 | 10.48 | 37.29 | **14.46** |
| | 23 | 7 | 5.03 | 11.30 | 15.40 | 12.70 | 45.56 | **16.20** |
| | 40 | 6 | 5.77 | 13.55 | 20.71 | 15.18 | 55.27 | **18.09** |
| | 60 | 5 | 6.56 | 16.12 | 26.75 | 17.94 | 66.13 | **20.04** |
| | 77 | 4 | 7.32 | 18.62 | 32.78 | 20.56 | 76.79 | **21.80** |
| | 89 | 3 | 8.01 | 21.01 | 38.77 | 23.04 | 86.96 | **23.27** |
| | 96 | 2 | 8.64 | 23.09 | 44.76 | 25.22 | 95.84 | **24.33** |
| | 100 | 1 | 9.19 | 24.89 | 51.96 | 27.17 | 103.44 | **24.99** |

**Table 8.17: Norms for tight-forwards on physical-motor: vertical jump**

| | Stanines | Percentiles | Vertical jump Best effort (cm) |
|---|---|---|---|
| n | | Valid | **250** |
| Percentiles | 1 | 4 | **43.35** |
| | 2 | 11 | **45.77** |
| | 3 | 23 | **48.69** |
| | 4 | 40 | **51.76** |
| | 5 | 60 | **54.92** |
| | 6 | 77 | **57.92** |
| | 7 | 89 | **60.45** |
| | 8 | 96 | **62.68** |
| | 9 | 100 | **63.72** |

**Table 8.18: Norms for tight-forwards on physical-motor skills: 10/40m dash and T-Test**

| | Stanines | Percentiles | 10m dash (1) (sec) | 10m dash (2) (sec) | *10m dash lowest score (sec)* | 40m dash (1) (sec) | 40m dash (2) (sec) | *40m dash lowest score (sec)* | T-Test (1) (sec) | T-Test (2) (sec) | *T-Test lowest score* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| n | | Valid | 250 | 250 | ***250*** | 250 | 250 | ***250*** | 250 | 250 | ***250*** |
| Percentiles | 9 | 4 | 1.892 | 1.914 | ***1.883*** | 5.513 | 5.428 | ***5.434*** | 10.677 | 10.594 | ***10.577*** |
| | 8 | 11 | 1.973 | 1.984 | ***1.950*** | 5.641 | 5.563 | ***5.558*** | 10.903 | 10.804 | ***10.767*** |
| | 7 | 23 | 2.064 | 2.054 | ***2.024*** | 5.795 | 5.719 | ***5.704*** | 11.211 | 11.104 | ***11.043*** |
| | 6 | 40 | 2.160 | 2.125 | ***2.097*** | 5.965 | 5.884 | ***5.862*** | 11.579 | 11.467 | ***11.380*** |
| | 5 | 60 | 2.261 | 2.195 | ***2.173*** | 6.146 | 6.064 | ***6.028*** | 12.007 | 11.884 | ***11.771*** |
| | 4 | 77 | 2.356 | 2.255 | ***2.238*** | 6.318 | 6.226 | ***6.186*** | 12.432 | 12.288 | ***12.153*** |
| | 3 | 89 | 2.443 | 2.305 | ***2.290*** | 6.483 | 6.368 | ***6.333*** | 12.856 | 12.674 | ***12.543*** |
| | 2 | 96 | 2.516 | 2.339 | ***2.328*** | 6.630 | 6.483 | ***6.456*** | 13.303 | 13.037 | ***12.910*** |
| | 1 | 100 | 2.574 | 2.358 | ***2.349*** | 6.761 | 6.565 | ***6.563*** | 13.957 | 13.338 | ***13.326*** |

**Table 8.19: Norms for tight-forwards on physical-motor skills: 3x5x22m Anaerobic Capacity and sport vision skills: Accuvision1000 "30 lights in fastest time" test**

| | Stanines | Percentiles | Anaerobic Capacity 5x22m set 1 (sec) | Anaerobic Capacity 5x22m set 2 (sec) | Anaerobic Capacity 5x22m set 3 (sec) | Accuvision 1000 Test (30 lights test) (sec) |
|---|---|---|---|---|---|---|
| n | | Valid | 250 | 250 | 250 | 250 |
| Percentiles | 9 | 4 | 20.748 | 21.672 | 22.179 | 19.81 |
| | 8 | 11 | 21.082 | 22.239 | 22.665 | 20.87 |
| | 7 | 23 | 21.443 | 22.876 | 23.333 | 22.12 |
| | 6 | 40 | 21.829 | 23.545 | 24.091 | 23.48 |
| | 5 | 60 | 22.221 | 24.274 | 24.930 | 24.96 |
| | 4 | 77 | 22.569 | 24.961 | 25.707 | 26.29 |
| | 3 | 89 | 22.860 | 25.639 | 26.405 | 27.47 |
| | 2 | 96 | 23.076 | 26.322 | 26.956 | 28.36 |
| | 1 | 100 | 23.208 | 27.049 | 27.347 | 28.95 |

**NORMS FOR TIGHT-FORWARDS**

**Table 8.16: Norms for tight-forwards on anthropometrical components**

| | Percentiles | Stanines | Biceps SF (mm) | Triceps SF (mm) | Suprailiac SF (mm) | Subscapular SF (mm) | Skin total | Body fat % vs. skinfold thickness |
|---|---|---|---|---|---|---|---|---|
| n | Valid | | 250 | 250 | 250 | 250 | 250 | **250** |
| Percentile | 4 | 9 | 3.83 | 8.08 | 7.97 | 8.83 | 31.18 | **13.01** |
| | 11 | 8 | 4.37 | 9.40 | 11.06 | 10.48 | 37.29 | **14.46** |
| | 23 | 7 | 5.03 | 11.30 | 15.40 | 12.70 | 45.56 | **16.20** |
| | 40 | 6 | 5.77 | 13.55 | 20.71 | 15.18 | 55.27 | **18.09** |
| | 60 | 5 | 6.56 | 16.12 | 26.75 | 17.94 | 66.13 | **20.04** |
| | 77 | 4 | 7.32 | 18.62 | 32.78 | 20.56 | 76.79 | **21.80** |
| | 89 | 3 | 8.01 | 21.01 | 38.77 | 23.04 | 86.96 | **23.27** |
| | 96 | 2 | 8.64 | 23.09 | 44.76 | 25.22 | 95.84 | **24.33** |
| | 100 | 1 | 9.19 | 24.89 | 51.96 | 27.17 | 103.44 | **24.99** |

**Table 8.17: Norms for tight-forwards on physical-motor: vertical jump**

| | Stanines | Percentiles | Vertical jump Best effort (cm) |
|---|---|---|---|
| n | | Valid | **250** |
| Percentiles | 1 | 4 | **43.35** |
| | 2 | 11 | **45.77** |
| | 3 | 23 | **48.69** |
| | 4 | 40 | **51.76** |
| | 5 | 60 | **54.92** |
| | 6 | 77 | **57.92** |
| | 7 | 89 | **60.45** |
| | 8 | 96 | **62.68** |
| | 9 | 100 | **63.72** |

**Table 8.18: Norms for tight-forwards on physical-motor skills: 10/40m dash and T-Test**

| | Stanines | Percentiles | 10m dash (1) (sec) | 10m dash (2) (sec) | *10m dash lowest score (sec)* | 40m dash (1) (sec) | 40m dash (2) (sec) | *40m dash lowest score (sec)* | T-Test (1) (sec) | T-Test (2) (sec) | *T-Test lowest score* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| n | | Valid | 250 | 250 | ***250*** | 250 | 250 | ***250*** | 250 | 250 | ***250*** |
| Percentiles | 9 | 4 | 1.892 | 1.914 | ***1.883*** | 5.513 | 5.428 | ***5.434*** | 10.677 | 10.594 | ***10.577*** |
| | 8 | 11 | 1.973 | 1.984 | ***1.950*** | 5.641 | 5.563 | ***5.558*** | 10.903 | 10.804 | ***10.767*** |
| | 7 | 23 | 2.064 | 2.054 | ***2.024*** | 5.795 | 5.719 | ***5.704*** | 11.211 | 11.104 | ***11.043*** |
| | 6 | 40 | 2.160 | 2.125 | ***2.097*** | 5.965 | 5.884 | ***5.862*** | 11.579 | 11.467 | ***11.380*** |
| | 5 | 60 | 2.261 | 2.195 | ***2.173*** | 6.146 | 6.064 | ***6.028*** | 12.007 | 11.884 | ***11.771*** |
| | 4 | 77 | 2.356 | 2.255 | ***2.238*** | 6.318 | 6.226 | ***6.186*** | 12.432 | 12.288 | ***12.153*** |
| | 3 | 89 | 2.443 | 2.305 | ***2.290*** | 6.483 | 6.368 | ***6.333*** | 12.856 | 12.674 | ***12.543*** |
| | 2 | 96 | 2.516 | 2.339 | ***2.328*** | 6.630 | 6.483 | ***6.456*** | 13.303 | 13.037 | ***12.910*** |
| | 1 | 100 | 2.574 | 2.358 | ***2.349*** | 6.761 | 6.565 | ***6.563*** | 13.957 | 13.338 | ***13.326*** |

**Table 8.19: Norms for tight-forwards on physical-motor skills: 3x5x22m Anaerobic Capacity and sport vision skills: Accuvision1000 "30 lights in fastest time" test**

| | Stanines | Percentiles | Anaerobic Capacity 5x22m set 1 (sec) | Anaerobic Capacity 5x22m set 2 (sec) | Anaerobic Capacity 5x22m set 3 (sec) | Accuvision 1000 Test (30 lights test) (sec) |
|---|---|---|---|---|---|---|
| n | | Valid | **250** | **250** | **250** | **250** |
| Percentiles | 9 | 4 | **20.748** | **21.672** | **22.179** | **19.81** |
| | 8 | 11 | **21.082** | **22.239** | **22.665** | **20.87** |
| | 7 | 23 | **21.443** | **22.876** | **23.333** | **22.12** |
| | 6 | 40 | **21.829** | **23.545** | **24.091** | **23.48** |
| | 5 | 60 | **22.221** | **24.274** | **24.930** | **24.96** |
| | 4 | 77 | **22.569** | **24.961** | **25.707** | **26.29** |
| | 3 | 89 | **22.860** | **25.639** | **26.405** | **27.47** |
| | 2 | 96 | **23.076** | **26.322** | **26.956** | **28.36** |
| | 1 | 100 | **23.208** | **27.049** | **27.347** | **28.95** |

**NORMS FOR LOOSE-FORWARDS**

**Table 8.20: Norms for loose-forwards on anthropometrical components**

| | Percentiles | Stanines | Biceps SF (mm) | Triceps SF (mm) | Suprailiac SF (mm) | Subscapular SF (mm) | Skin total | Body fat % vs. skinfold thickness |
|---|---|---|---|---|---|---|---|---|
| n | Valid | | 250 | 250 | 250 | 250 | 250 | **250** |
| Percentiles | 4 | 9 | 3.39 | 6.13 | 7.64 | 7.76 | 27.45 | **11.88** |
| | 11 | 8 | 3.80 | 7.34 | 9.05 | 8.64 | 30.65 | **12.94** |
| | 23 | 7 | 4.35 | 8.74 | 11.14 | 9.75 | 34.86 | **14.18** |
| | 40 | 6 | 5.01 | 10.20 | 13.78 | 10.93 | 39.74 | **15.52** |
| | 60 | 5 | 5.74 | 11.79 | 16.89 | 12.23 | 45.23 | **16.97** |
| | 77 | 4 | 6.48 | 13.32 | 20.07 | 13.49 | 50.78 | **18.41** |
| | 89 | 3 | 7.21 | 14.87 | 23.36 | 14.76 | 56.50 | **19.86** |
| | 96 | 2 | 7.80 | 16.46 | 27.00 | 16.09 | 62.65 | **21.45** |
| | 100 | 1 | 9.16 | 18.88 | 35.74 | 18.33 | 75.35 | **24.49** |

**NORMS FOR LOOSE-FORWARDS**

**Table 8.20: Norms for loose-forwards on anthropometrical components**

| | Percentiles | Stanines | Biceps SF (mm) | Triceps SF (mm) | Suprailiac SF (mm) | Subscapular SF (mm) | Skin total | Body fat % vs. skinfold thickness |
|---|---|---|---|---|---|---|---|---|
| n | Valid | | 250 | 250 | 250 | 250 | 250 | **250** |
| Percentiles | 4 | 9 | 3.39 | 6.13 | 7.64 | 7.76 | 27.45 | **11.88** |
| | 11 | 8 | 3.80 | 7.34 | 9.05 | 8.64 | 30.65 | **12.94** |
| | 23 | 7 | 4.35 | 8.74 | 11.14 | 9.75 | 34.86 | **14.18** |
| | 40 | 6 | 5.01 | 10.20 | 13.78 | 10.93 | 39.74 | **15.52** |
| | 60 | 5 | 5.74 | 11.79 | 16.89 | 12.23 | 45.23 | **16.97** |
| | 77 | 4 | 6.48 | 13.32 | 20.07 | 13.49 | 50.78 | **18.41** |
| | 89 | 3 | 7.21 | 14.87 | 23.36 | 14.76 | 56.50 | **19.86** |
| | 96 | 2 | 7.80 | 16.46 | 27.00 | 16.09 | 62.65 | **21.45** |
| | 100 | 1 | 9.16 | 18.88 | 35.74 | 18.33 | 75.35 | **24.49** |

**Table 8.21: Norms for loose-forwards on physical-motor skills: vertical jump**

| | Stanines | Percentiles | Vertical jump best effort (cm) |
|---|---|---|---|
| n | | Valid | **250** |
| Percentiles | 1 | 4 | **42.50** |
| | 2 | 11 | **45.49** |
| | 3 | 23 | **48.71** |
| | 4 | 40 | **51.92** |
| | 5 | 60 | **55.23** |
| | 6 | 77 | **58.42** |
| | 7 | 89 | **61.32** |
| | 8 | 96 | **64.32** |
| | 9 | 100 | **66.31** |

**Table 8.22: Norms for loose-forwards on physical- motor skills: 10/40m dash and T-Test**

| | Stanines | Percentiles | 10m dash (1) (sec) | 10m dash (2) (sec) | *10m dash lowest score (sec)* | 40m dash (1) (sec) | 40m dash (2) (sec) | *40m dash lowest score (sec)* | T-Test (1) (sec) | T-Test (2) (sec) | *T-Test lowest score* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| n | | Valid | 250 | 250 | ***250*** | 250 | 250 | ***250*** | 250 | 250 | ***250*** |
| Percentiles | 9 | 4 | 1.719 | 1.744 | ***1.743*** | 5.076 | 5.327 | ***5.058*** | 10.039 | 9.905 | ***9.887*** |
| | 8 | 11 | 1.804 | 1.812 | ***1.809*** | 5.237 | 5.411 | ***5.193*** | 10.237 | 10.094 | ***10.059*** |
| | 7 | 23 | 1.9034 | 1.890 | ***1.889*** | 5.424 | 5.520 | ***5.345*** | 10.505 | 10.356 | ***10.304*** |
| | 6 | 40 | 2.0112 | 1.979 | ***1.974*** | 5.626 | 5.644 | ***5.507*** | 10.824 | 10.667 | ***10.599*** |
| | 5 | 60 | 2.127 | 2.075 | ***2.068*** | 5.841 | 5.787 | ***5.676*** | 11.192 | 11.023 | ***10.940*** |
| | 4 | 77 | 2.238 | 2.166 | ***2.158*** | 6.047 | 5.923 | ***5.840*** | 11.550 | 11.373 | ***11.275*** |
| | 3 | 89 | 2.344 | 2.257 | ***2.245*** | 6.251 | 6.056 | ***5.999*** | 11.894 | 11.722 | ***11.625*** |
| | 2 | 96 | 2.441 | 2.344 | ***2.3367*** | 6.446 | 6.183 | ***6.146*** | 12.221 | 12.090 | ***11.976*** |
| | 1 | 100 | 2.529 | 2.426 | ***2.435*** | 6.662 | 6.309 | ***6.306*** | 12.553 | 12.515 | ***12.496*** |

**Table 8.23: Norms for loose-forwards on physical-motor skills: 3x5x22m Anaerobic Capacity and sport vision skills: Accuvision1000 "30 lights in fastest time" test**

| | Stanines | Percentiles | Anaerobic Capacity 5x22m set 1 (sec) | Anaerobic Capacity 5x22m set 2 (sec) | Anaerobic Capacity 5x22m set 3 (sec) | Accuvision 1000 Test (30 lights test) (sec) |
|---|---|---|---|---|---|---|
| n | | Valid | **250** | **250** | **250** | **250** |
| Percentiles | 9 | 4 | **20.049** | **20.868** | **20.490** | **18.46** |
| | 8 | 11 | **20.438** | **21.247** | **21.026** | **19.20** |
| | 7 | 23 | **20.860** | **21.717** | **21.615** | **20.23** |
| | 6 | 40 | **21.318** | **22.236** | **22.211** | **21.49** |
| | 5 | 60 | **21.803** | **22.815** | **22.843** | **22.97** |
| | 4 | 77 | **22.269** | **23.369** | **23.432** | **24.40** |
| | 3 | 89 | **22.727** | **23.917** | **23.994** | **25.77** |
| | 2 | 96 | **23.191** | **24.470** | **24.501** | **26.96** |
| | 1 | 100 | **23.686** | **25.059** | **24.961** | **27.90** |

**NORMS FOR BACKS**

**Table 8.24: Norms for backs on anthropometrical components**

| | **Percentiles** | **Stanines** | **Biceps SF (mm)** | **Triceps SF (mm)** | **Suprailiac SF (mm)** | **Subscapular SF (mm)** | **Skin total** | **Body fat % vs. skinfold thickness** |
|---|---|---|---|---|---|---|---|---|
| n | 250 | | 250 | 250 | 250 | 250 | 250 | **250** |
| Percentiles | 4 | 9 | 3.64 | 6.40 | 6.78 | 6.82 | 26.09 | **11.18** |
| | 11 | 8 | 4.00 | 7.57 | 8.73 | 7.95 | 30.11 | **12.53** |
| | 23 | 7 | 4.54 | 9.00 | 11.45 | 9.30 | 35.44 | **14.12** |
| | 40 | 6 | 5.20 | 10.53 | 14.73 | 10.73 | 41.65 | **15.84** |
| | 60 | 5 | 5.98 | 12.19 | 18.48 | 12.29 | 48.65 | **17.68** |
| | 77 | 4 | 6.77 | 13.79 | 22.24 | 13.80 | 55.72 | **19.49** |
| | 89 | 3 | 7.58 | 15.37 | 26.05 | 15.34 | 62.99 | **21.25** |
| | 96 | 2 | 8.49 | 16.90 | 30.09 | 16.99 | 70.70 | **23.02** |
| | 100 | 1 | 10.68 | 18.66 | 36.55 | 20.72 | 84.45 | **24.96** |

**Table 8.25: Norms for backs on physical-motor skills: vertical jump**

| | Stanines | Percentiles | Vertical jump best effort (cm) |
|---|---|---|---|
| n | | Valid | **250** |
| Percentiles | 1 | 4 | **43.66** |
| | 2 | 11 | **46.31** |
| | 3 | 23 | **48.69** |
| | 4 | 40 | **51.30** |
| | 5 | 60 | **53.92** |
| | 6 | 77 | **56.52** |
| | 7 | 89 | **59.03** |
| | 8 | 96 | **61.72** |
| | 9 | 100 | **64.91** |

**Table 8.26: Norms for Backs on Physical Motor Skills – Dash and T-test**

| | Stanines | Percentiles | 10m dash (1) (sec) | 10m dash (2) (sec) | *10m dash lowest score (sec)* | 40m dash (1) (sec) | 40m dash (2) (sec) | *40m dash lowest score (sec)* | T-Test (1) (sec) | T-Test (2) (sec) | *T-test lowest score* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| n | | Valid | 250 | 250 | ***250*** | 250 | 250 | ***250*** | 250 | 250 | ***250*** |
| Percentiles | 9 | 4 | 1.797 | 1.893 | ***1.788*** | 5.197 | 5.182 | ***5.117*** | 9.573 | 9.726 | ***9.480*** |
| | 8 | 11 | 1.860 | 1.938 | ***1.840*** | 5.306 | 5.322 | ***5.219*** | 9.943 | 9.957 | ***9.790*** |
| | 7 | 23 | 1.939 | 1.994 | ***1.906*** | 5.447 | 5.465 | ***5.346*** | 10.335 | 10.290 | ***10.165*** |
| | 6 | 40 | 2.028 | 2.058 | ***1.978*** | 5.608 | 5.608 | ***5.487*** | 10.746 | 10.695 | ***10.571*** |
| | 5 | 60 | 2.123 | 2.129 | ***2.059*** | 5.785 | 5.764 | ***5.639*** | 11.189 | 11.166 | ***11.014*** |
| | 4 | 77 | 2.215 | 2.197 | ***2.138*** | 5.958 | 5.910 | ***5.790*** | 11.611 | 11.624 | ***11.435*** |
| | 3 | 89 | 2.302 | 2.263 | ***2.215*** | 6.132 | 6.052 | ***5.941*** | 12.019 | 12.067 | ***11.864*** |
| | 2 | 96 | 2.378 | 2.326 | ***2.296*** | 6.303 | 6.194 | ***6.095*** | 12.430 | 12.492 | ***12.281*** |
| | 1 | 100 | 2.442 | 2.381 | ***2.385*** | 6.511 | 6.354 | ***6.333*** | 12.946 | 12.862 | ***12.825*** |

**Table 8.27: Norms for backs on physical-motor skills: 3x5x22m Anaerobic Capacity and sport vision skills: Accuvision1000 "30 lights in fastest time" test**

| | Stanines | Percentiles | Anaerobic Capacity 5x22m set 1 (sec) | Anaerobic Capacity 5x22m set 2 (sec) | Anaerobic Capacity 5x22m set 3 (sec) | Accuvision 1000 Test (30 lights test) (sec) |
|---|---|---|---|---|---|---|
| n | | Valid | **250** | **250** | **250** | **250** |
| Percentiles | 9 | 4 | **19.655** | **20.465** | **21.060** | **17.74** |
| | 8 | 11 | **20.236** | **21.066** | **21.468** | **18.84** |
| | 7 | 23 | **20.798** | **21.767** | **22.012** | **20.28** |
| | 6 | 40 | **21.376** | **22.519** | **22.622** | **21.93** |
| | 5 | 60 | **21.965** | **23.350** | **23.308** | **23.80** |
| | 4 | 77 | **22.504** | **24.148** | **23.981** | **25.50** |
| | 3 | 89 | **22.990** | **24.964** | **24.673** | **27.02** |
| | 2 | 96 | **23.401** | **25.870** | **25.421** | **28.17** |
| | 1 | 100 | **23.694** | **27.506** | **26.832** | **28.93** |

### 8.5.1 Norm tables of S-Test as determined for the second and third measurement combined

As indicated earlier, it was not possible to simulate the results obtained for the S-Test due to the fact that total scores obtained were on a nominal level. Simulations would result in scores that would not typically be obtained during the testing process and would thus not be practical for future reference and use. Since the second and third measurement of the S-Test included 2 aspects, namely accuracy and time taken to complete the test, a combined score was determined to get a total score for the S-Test. This was done for the following reason: some players scored zero points but took less time to complete the test. By simply looking at the time taken to complete the test, an inaccurate impression of the relative performance could be created since zero points could be scored in a shorter space of time as opposed to 10 points over a longer space of time. It was thus decided to combine the points scored with the time taken to complete the task to get a total score.

For the S-Test, higher scores are associated with a better performance, but, since there is also a time factor involved with this test, as mentioned before, possible discrepancies could arise as to the true reflection of the scores obtained in this test. To address this potential problem and in order to rule out the discrepancy between longer times taken to complete the task resulting in higher performance scores as opposed to less time taken to score the same number of points, the following solution was devised: the mean score in terms of time taken to complete the test is used to categorise performance into two groups.

These two groups consist of the following: 1) those subjects who took less than and equal to the average time (sec) taken by that grouped position to complete the task; they are assigned 2 “multiplier” points; 2) those subjects who completed the task in longer than the average time (sec) for that grouped position; they are assigned 1 “multiplier” point. A total and final score for this S-Test is then calculated by multiplying the points scored for accuracy (best attempt) with the “multiplier” points (1 or 2) that the subject receives for performing the task relative to the mean time of completion for a particular positional grouping. The final score for the S-Test is then a computed score that takes into account the accuracy of the subject in performing this task while also considering the time taken to perform this task.

The results of this S-Test are discussed hereafter. For the two sample groups, the mean scores on the recorded time taken to complete the S-Test per positional grouping were analysed. This was followed by a computation of the time taken versus accuracy attained, where the relative scores were assigned multiplier points of 1 or 2 respectively and multiplied with these points. The means scores on recorded time taken per positional grouping are presented in table 8.28 followed by the frequency distributions of the computed totals in tables 8.29 to 8.31.

A full explanation of the implications of this scoring system for this test per position is provided thereafter.

**Table 8.28: Mean scores on recoded time taken to complete the S-Test per positional grouping**

| Grouped Positions | | S-Test 1 (Sec) | S-Test 2 (Sec) |
|---|---|---|---|
| Tight-forwards | N | Valid | 14 |
| | | Missing | 1 |
| | Mean | 7.630 | 7.604 |
| | Median | 7.585 | 7.630 |
| | Mode | 6.91(a) | 7.66 |
| Loose-forwards | N | Valid | 17 |
| | | Missing | 1 |
| | Mean | 7.299 | 7.002 |
| | Median | 7.230 | 6.980 |
| | Mode | 6.27(a) | 5.65(a) |
| Backs | N | Valid | 18 |
| | | Missing | 1 |
| | Mean | 7.709 | 7.339 |
| | Median | 7.680 | 7.395 |
| | Mode | 6.68(a) | 7.50 |

**(a) Multiple modes exist. The smallest value is shown**

**Table 8.29: Frequencies for tight-forwards best attempt on S-Test computed total**

| | Score obtained | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | .00 | 2 | 13.3 | 14.3 | 14.3 |
| | 5.00 | 4 | 26.7 | 28.6 | 42.9 |
| | 10.00 | 7 | 46.7 | 50.0 | 92.9 |
| | 20.00 | 1 | 6.7 | 7.1 | 100.0 |
| | Total | 14 | 93.3 | 100.0 | |
| Missing | System | 1 | 6.7 | | |
| Total | 15 | 100.0 | | | |

**Table 8.30: Frequencies for loose-forwards best attempt on S-Test computed total**

| | Score obtained | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 0.00 | 1 | 5.6 | 5.9 | 5.9 |
| | 5.00 | 2 | 11.1 | 11.8 | 17.6 |
| | 10.00 | 10 | 55.6 | 58.8 | 76.5 |
| | 20.00 | 4 | 22.2 | 23.5 | 100.0 |
| | Total | 17 | 94.4 | 100.0 | |
| Missing | System | 1 | 5.6 | | |
| Total | 18 | 100.0 | | | |

**Table 8.31: Frequencies for backs best attempt on S-Test computed total**

| | Score obtained | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 0.00 | 1 | 5.3 | 5.6 | 5.6 |
| | 5.00 | 1 | 5.3 | 5.6 | 11.1 |
| | 10.00 | 11 | 57.9 | 61.1 | 72.2 |
| | 20.00 | 5 | 26.3 | 27.8 | 100.0 |
| | Total | 18 | 94.7 | 100.0 | |
| Missing | System | 1 | 5.3 | | |
| Total | 19 | 100.0 | | | |

#### 8.5.1.1 Implications of the scoring system for the S-Test

There are a number of implications that can be derived from the scoring system adopted for this S-Test. These are discussed hereafter, as well as the results from tables 8.29 to 8.31 presented earlier:

##### *8.5.1.1.1 Zero score*

A score of zero means that the subject was inaccurate with all their passes, irrespective of the time taken to complete the course itself. This is a poor reflection on the subject's passing skills. 14.3% of the tight-forwards, 5.9% of the loose-forwards and 5.6% of the backs achieved this score.

##### *8.5.1.1.2 Five score*

According to the scoring system for this test, obtaining five computed points for this test means the subject only had one accurate pass and that they completed the course in more time than the mean time. This is therefore a bad reflection on the subject's ability to pass accurately at speed or under pressure. 28.6% of the tight-forwards, 11.8% of the loose-forwards and 5.6% of the backs obtained this score.

##### *8.5.1.1.3 Ten score*

The computed score of 10 points can be interpreted according to two possible scenarios:

a) The first possible interpretation is that while the accuracy of the subjects in this category score was high (10 points=2 accurate passes, 1 left and 1 right), their overall time taken to complete the test was more than the mean time, earning them one multiplier point and a computed score of ten.

b) The other alternative is that the subjects were less accurate (5 points=1 accurate pass), but they completed the test in less than the mean time, earning them two multiplier points so that they therefore receive a computed score of ten for this test.

While this category is obviously better than the preceding two categories, it is still not the ideal. It could reflect that while the subjects are more accurate in their passing at speed, they need more time in which to complete their accurate passes, implying a possible inability to operate under pressure. In the high-pressure game of rugby, which is often played at high speed, this could present a problem.

By far the largest majority of all the positional groupings fell into this category, with 50% of the tight-forwards, 58.8% of the loose-forwards and 61.1% of the backs achieving this score.

*8.5.1.1.4 Twenty score*

Obtaining a computed score of 20 implies that the subject is highly skilled in passing at speed and under pressure since they are accurate with their passes to both sides (10 points = 2 accurate passes, 1 left and 1 right) and they managed to complete the course in less time than the mean, accruing two multiplier points to take the computed total to 20 points. This is by far the ideal score to achieve for this test. 7.1% of the tight-forwards, 23.5% of the loose-forwards and 27.8% of the backs achieved this score.

From the results of tables 8.29 to 8.30, it seems that while a computed total S-Test score of 20 is *obviously* the ideal; a more realistic computed total S-test score of 10 can be used as the norm to differentiate between good and poor performances. In suggesting this, however, it must be remembered that the different positions as grouped in this study and in general often have divergently different tasks to perform on field. While the tight-forwards tend to be more focused on set-phases (scrums and line-outs), the loose-forwards and backs tend to be more involved in the running and open play requiring a higher passing ability. The scores seem to reflect the general trends in rugby today. Higher numbers of backs achieved scores of 10 (61.1%) and 20 (27.8%) as opposed to both loose-forwards (55.6% and 22.2%) and tight-forwards (46.7% and 6.75) respectively, showing that the loose-forwards and backs have better handling skills than the tight-forwards.

The value of this test is further underscored by the fact that while norms have been provided for future reference, the intra-group passing ability can also be determined. As a result, the weaker passers in the team can be identified and these individuals can be further addressed.

While rugby is constantly changing and while the rugby-specific skills, as proposed by Robbie Deans, are becoming more generic with all positions required to perform them, for the time being it seems as if the status quo remains, particularly in South African rugby.

## 8.6 SUMMARY OF RESULTS

As indicated throughout this document, the focus was on young elite (age-group) rugby players represented by the U/21 Blue Bulls squad, the South African U/21 squad and the Tuks Rugby Academy squad. Approximately a third of the sample was represented by tight-forwards, loose-forwards and backs respectively. Their ages ranged between 19 and 25 but, 94.8% of the sample were 21 years and younger. Almost two thirds (65.4%) of the sample group were injury free. The most common injuries encountered during testing were those of the knee (9%), the hamstring (6.4%) and the ankle (5.1%). As a result, the testing approach to these injured individuals accommodated their injuries as safely as possible.

### 8.6.1 Summary of inconsistent tests

As a result of this protocol evolving from test to test, the measurement of some of the variables were not kept consistent over the three measurements. Therefore norms could only be determined for those variables that were measured consistently since these variables consisted of a reasonable base size. Descriptive statistics for these inconsistent variables have been provided for reference purposes.

The Scrumhalf tyre pass and the Hooker Throw in at 6m, 8m and 10m had very small base sizes and did not adequately simulate the game environment. It is for this reason that these tests were discarded. The Kick for Accuracy (quadrant) was incredibly difficult and was discarded as a result, with the associated suggestion being that this test be modified into a training drill for kicking accuracy. The Accuvision1000 “120 lights” test took too long to perform and was discarded as a field testing test, with the associated suggestion being that it be used for laboratory testing.

Further brief commentary will be provided for the S-Test, the Kick for Distance and the Kick for Distance and Accuracy tests.

In the first S-Test measurement (protocol 1), most players had an almost perfect score out of 30 with a mean of 29.86. This high level of success was attributed to the “live” targets that were used for protocol one and the fact that they compensated for bad passes by making an effort to retrieve these wayward passes. Changes were brought about for protocol 2 as described in chapter seven.

The scores and the scoring process were discussed in the preceding section of this chapter. The final S-Test in its current form has been included in the final test protocol for this study. What can be said about this test, however, is that the backs outperformed the tight-forwards and loose-forwards and therefore have better passing (under pressure) skills at speed than do the forwards. The further intra-group advantage of this test has been discussed earlier.

For the Kick for Distance test, the Blue Bulls U/21 showed a higher average kick for distance score with means between 45 and 49 metres followed by the South Africa U/21 with means ranging between 23 and 31 metres. The large differences between these groups cannot be explained and the suggestion has been made that the scores of the Blue Bulls U/21 be used for future reference and comparison. While this test was modified to form the kick for distance and accuracy test when testing the Tuks Rugby Academy in test 3/protocol 3, it is still a very valid and reliable test for kicking ability and can also be used in the future. Means and standard deviations have been provided for this purpose. With the Kick for Distance and Accuracy as performed on the TUKS Rugby Academy, means ranging between 32 and 39 have been provided for future reference and comparison. This Kick for distance and accuracy test has been included in the final test protocol suggested by this study. To be remembered, however, is that in all three these cases, dominant foot preference is also sure to have played a role in performance.

### 8.6.2 Summary of consistent tests

From the results of the Kruskall-Wallis tests that tested for statistically significant differences between the three groupings of players the following can be stated:

1) The height and body mass of backs were significantly lower than those of tight-forwards and the loose-forwards. Statistically significant differences were found on all but the triceps skinfold measurement where anthropometrical components were concerned. The measurements of the tight-forwards were statistically significantly higher than the loose forwards and backs. This was especially true for the Body Fat % versus Skinfold measurement.

2) As far as the Physical Motor skills are concerned, no statistically significant difference was found on the vertical jump scores. The backs and the loose-forwards performed significantly better on the 10 metre dash test, with backs performing best in the 10m and 40m metre dash, followed by the loose-forwards. Both performances were statistically significantly higher than the other positions.

Tight-forwards had statistically significant higher T-Test scores than the other two positions, indicating that they took significantly longer to complete the test. Statistically significant differences were also found amongst the tight-forwards on the second and last 3x5x22m Anaerobic Capacity Test. The tight-forwards once again had statistically significant higher scores, indicating a poorer performance on this test.

There were no statistically significant differences found on the Accuvision1000 "30 accurate lights in the fastest time" test although the loose-forwards outperformed the backs who in turn outperformed the tight-forwards.

The norms tables are not summarised and are indicated in prior tables. It should be noted that the categories are non-adjacent from one level to the next. This is caused by, amongst other things, the fact that the data that was worked with was done so on a ratio level with 2 decimal places and that with the relatively small sample sizes, all the possibilities could not be included, even in the simulations.

It is advised that all the scores obtained in subsequent testing according to this protocol and associated norms be measured against these tables by rounding down to the lower category. Therefore, if category one ends at 2.3 and category two starts at 2.5, all measurements lower than 2.5 be considered to fall in category one.

The results of the calculated S-Test total score could not be simulated due to the categorical nature of the data. Players could score 0, 5, 10 and 20 respectively and it was simply not practical to simulate these scores for a bigger sample. The results of frequency distributions per position were thus used to get an indication of performance.

These results indicated that across the grouped positions, a total calculated S-Test score of 10 seems to discriminate between poor and better performances. A smaller proportion of tight-forwards scored 10 points and larger proportion scored five points or less, possibly indicating the differences in roles between the grouped positions. The number of players against which these score were determined was low however, and should this specific test should be investigated further in other studies.

In conclusion of this section, the loose-forwards outperformed the tight-forwards and the backs in everything except body mass, stature and vertical jump in which the tight forwards had the highest scores, as well as the subscapular skinfold, the S-Test for passing accuracy, the 10m and the 40 metre dash in which the backs had the better scores. In these tests, however, the loose-forwards consistently had the second best scores followed by the remaining position. It is common knowledge that South Africa is “blessed” with multitude of skilled and able loose-forwards and this continued tend is confirmed by these tests. In chapter nine, conclusions and recommendations are made based on the two main aims of this study. Conclusions and recommendations will also be made regarding the empirical design and approach adopted by this study.

# CHAPTER NINE

# CONCLUSIONS AND RECOMMENDATIONS

## 9.1 INTRODUCTION

Throughout the course of this study, the primary aims leading this study were noted. The first aim is to conduct an in-depth and exhaustive review of the literature so as to provide a sufficient foundation and basis for this study. The second main aim is to provide an alternative sport and position-specific testing protocol as well as comparative results consisting of norms and scores that will adequately identify and select those capable of participating in elite age-group rugby union. Furthermore, the hypothesis noted in chapter one is as follows: the findings of this study will contribute meaningfully to elite rugby union by providing sport and position specific test protocols as well as norms and standards for comparison.

The discussion contained in this chapter will therefore focus on these two main aims as well as the hypothesis. After every chapter conclusions and recommendations were provided in the summary section and these can serve as extra references in this regard.

### 9.1.1 Chapter outline

*Section one: conclusions and recommendations from literature*

In this section the pre-existing conclusions and recommendations established earlier from the in-depth and exhaustive literature review are re-evaluated, and where appropriate extra conclusions and recommendations are formulated.

*Section two: conclusions and recommendations from the empirical investigation*

In this section conclusions and recommendations from the empirical investigation will be formulated.

*Section three: conclusions and recommendations regarding study hypothesis*

In this section an evaluation of the hypothesis of this study in relation to the literature and the empirical investigation is provided.

## 9.2 CONCLUSIONS AND RECOMMENDATIONS FROM LITERATURE

### 9.2.1 Terms and concepts

It is concluded that the terms and concepts applicable to talent identification and expert performance need further clarification. While the terms identification, detection, selection and development as these pertain to talent are on the whole self explanatory, or perhaps *more readily* explained and thus understood, the issue surrounding the concept of talent per se is still greatly debated, with extensive argument emanating from the literature. In fact, the concept of expert performance itself can be seen to be affected by the same arguments that rage around the concept of talent and talented performance. In many instances, while the differences in perspective between expert performance and talented performance can be regarded as being a case of mere semantics, these differences can be seen as being the result of the unresolved nature versus nurture debate and related issues.

There is very little consensus and, the truth be told, there probably never will be. This in itself is not a bad thing, but what this debate has caused, or rather prevented, is the development of an all-encompassing model of talent (and expert performance) that satisfies all parties. In chapter two, certain sections of Gagné's (1985; 2003; 2005) Differentiated Model of Giftedness and Talent (DMGT) in Van Rossum and Gagné (2005) were examined. The adoption of this model to serve as a framework for further research and investigation, as proposed by Vaeyens *et al.* (submitted), is certainly a viable and worthy consideration and is, for the purposes of this section, recommended. It could perhaps be seen as a starting point in bringing the divergent views of all parties together, at least partly. This recommendation also serves true for the later discussion regarding the nature/nurture issue.

### 9.2.2 Sport and rugby

Sport is an ever-evolving practice and none more so than rugby. This evolution was described at length in chapter three. Rugby is still evolving regarding the rules of and the approach to the game. This is being done for the sole purpose of making the game more attractive to the masses and is another example of the on-going commercialisation of the "product" called rugby. This has the potential of affecting the ethos of the game. The question needs to be asked: is it a bad thing? How long ago was professional rugby, or any competitive sport for that matter, played solely for "the love of it?"

Probably the biggest catalyst for change was the professionalisation of the game after the 1995 IRB World Cup (Treasure *et al.,* 2000; Garraway *et al.,* 2000; Hattingh, 2003; Van Gent, 2003; Quarrie & Hopkins, 2007) with the effects resonating to this day. From the evidence gained from the literature and from the press, it is concluded that rugby will for a while still be an evolving game, until such a time as a balance can be struck between what appeals and what is meaningful. What can be concluded from this, however, is that there is certainly an increased focus on talent identification and development in rugby since 1995, especially in South Africa (see all the rugby-related talent identification references in this regard), with this increase being for the purpose of ensuring sustained success on the international front through the identification and subsequent development of talented players. No recommendations can be proffered regarding the evolution of rugby, since any recommendations proposed would fall outside the scope of this study.

### 9.2.3 Physical perspectives

It was noted in chapter three that mental, sport-specific, physical and tactical attributes and skills are needed for success in rugby (Quarrie & Wilson, 2000; Hale & Collins, 2002; Luger & Pook, 2004; Durandt *et al.,* 2006; Duthie, 2006) and that in the last century, and in particular the last twenty five to thirty five years, substantial increases have been observed in the sizes of physiques of rugby players (Olds, 2001; Luger & Pook, 2004; Quarrie & Hopkins, 2007).

Subsequently, in chapter four the analyses of the physical requirements that Duthie (2006) and others provided were reviewed. This also included sport-specific skill. Investigating the sport-specific skill aspect in rugby is also not a new thing, with Pienaar and Spamer (1995) in Pienaar and Spamer (1998) being the first to do so. Since rugby is a collision sport (Hattingh, 2003; Gabbett & Domrow, in press) that places great physical requirements upon the participants, the physical aspects predominate more in this sport than certain others, and it is concluded that the physical aspects of the game will receive even greater consideration in the future as the game continues to evolve. This places even more pressure on talent identification researchers and proponents to monitor this progression and to provide as up-to-date prediction functions and further norms and standards for comparison as possible.

Concern over this is unfounded however, considering the literature emanating from a South African context in this regard. Furthermore, any recommendations in this regard are superfluous, considering the steady flow of research into talent identification and development as this pertains to rugby. Obviously, this is not as voluminous as it could be, but it is certainly the predominant sport under investigation.

Maturation and growth considerations continue to predominate in talent identification and expert performance literature, and for good reason. The relative rate of maturation has a profound effect on individuals at childhood or adolescent level. Early maturation is certainly a consideration and it has been recommended by some (Hahn & Gross, 1990) that results be compared specifically to biological age as opposed to chronological age, since late maturers tend to be at a disadvantage when compared to chronological, age based norms and standards (Vaeyens *et al.,* submitted). Biological age considerations from a South African perspective were also raised some time ago by du Randt and Headley (1992c).

The relative-age effect is well documented (see chapter six) and has also been researched within the South African context, with confirmatory results (Spamer & Winsley, 2003b) found. Those indicating a relative-age effect tend to be advantaged in selection and subsequent development (Musch & Grondin, 2001; Vaeyens *et al.,* 2005a; Côté *et al.,* 2007; Medic *et al.,* in press; Vaeyens *et al.,* submitted).

It is concluded that while maturation, growth and the relative-age effects are issues that are proven to exist, not much can constructively be done about them. Sport is by its nature a selective endeavour, and physically so. It is vital that talent identification acknowledges these issues, however, and that talent development be implemented to address these issues. Through the process of talent development these late bloomers can be brought up to standard, albeit at a later stage. What talent development can serve to do, further, is to develop the inherent skills specific to the sport under consideration, so that when the rate of maturation of the late-bloomers reaches those of the early maturers, as it inevitably does (Philippaerts *et al.,* 2006; Vaeyens *et al.,* submitted), there are no further backlogs. This also serves as a recommendation of this study.

**9.2.3.1 Nature versus nurture**

The issue of genetics, heredity and heritability have also been discussed at length in chapter four. The general heritability estimates of a number of motor, physical and physiological abilities and attributes were provided. Some of these were then subsequently countered in the rebuttal section of the chapter. After that, the role of the family and significant others within the context of talent and its development was reviewed. It is challenging to provide either conclusions or recommendations in this regard, since the nature-nurture argument is an unresolved matter that has been raging on for well over a century.

The specific conclusion of this study, however, is contained in the view that this study adopts on this matter, i.e.: that is that there both are genetic and environmental factors that play a role in talent and its subsequent development.

Therefore, the genetic potential of the individual will only be achieved through exhaustive and continued interaction with the environment, and this interaction has to be specific, targeted and sustained. The role of the parents and significant others in this regard are critical and should *never* be disregarded. As was shown, the role of parents in the lives and the development of well-balanced and talented individuals are non-negotiable. The role of the coach and peers are also important determinants and these should be fostered at all costs.

Specific recommendations of this study are that while research abounds regarding the role of parents and even coaches, perhaps more research needs to be aimed at investigating the specific role that the peer group plays in the process of developing talent and the child as a whole, since research on this issue is admittedly scarce (see chapter four). It was noted that some peer relationships are at best tenuous during adolescence and these could certainly have an impact on sustained sport participation if peer influence is the overriding consideration and motivation for practice and participation.

Also, further historical and current talent and expertise developmental models were presented in chapter four. Ranging from the ground breaking research of Bloom (1985) and progressing through to the equally seminal works of Ericsson *et al.* *(*1993), Côté (1999), Côté *et al.* (2007) and finally Button and Abbott (2007), these works have all provided outlooks on talent development that can be lauded more for what they have in common as opposed to where they differ. These models were in fact included for this reason. These works portray the general thinking of talent development, as do the specific approaches to talent development that were provided in chapter six.

The specific conclusions of this study pertaining to these models and talent (expertise) development is that they are all applicable and that there is very little difference between them. The specific preference of this study, however, is the model of Button and Abbott (2007). This model can be seen as being particularly relevant to *both* talent identification and development due to the fact that it has been included as a facilitating aspect in earlier attempts (Abbott & Collins, 2004; Abbott *et al.,* 2005) at combining talent identification and development into one, all encompassing model. This specific version of the model was included in this study for its recent and contemporary perspective on the development of talent.

For a further summary and some associated conclusions and recommendations please consult section 4.5 of chapter four. In this section also note the more recent research concerning the *birth-place* effect in talent development.

### 9.2.4 Psychological perspectives

A strong case was made for psychological considerations in talent identification and even development. From the literature it is clear that certain attributes such as motivation, commitment and practice are indeed needed to achieve elite status in sport. A specific construct, namely mental toughness, was reviewed. This is an all-encompassing construct that deals with the more traditional considerations such as anxiety, fear and even motivation but also, further, describes the individual's mental preparedness and ability to cope with pressure and the demands that elite sport place on an individual.

This study proposed earlier, and is currently reiterating this proposal again that the Elite Athlete Development Model of Cooper and Goodenough (2007) be the model of choice for talent identification and development. This is also the final conclusion of this study regarding the concept of mental toughness and its measurement and identification. This study recommends that appropriate steps be taken to incorporate this model within the structures of SA Rugby and the provincial unions country wide. If a certain amount of sentiment can be allowed at this time, then the following can be ventured: South Africa is widely regarded as having the highest number of talented rugby players (largest talent pool) of all the rugby playing countries in the world. Furthermore, South Africa's players are regarded of the best in the world, with their recent crowning as two time world champions confirming this.

In putting patriotism to one side though, it must unfortunately be honestly acknowledged that in the not too distant past the results have not always reflected this supposed superiority. While a small proportion of the blame can be attributed to the physical preparedness of the players (although currently this has been adequately addressed), and largest and probably overriding proportion of this can be attributed to mental preparation and, to a lesser yet still important extent, the rugby-specific skills. These issues need to be addressed and the recommendations made throughout this study in this regard apply forthwith.

It has been suggested by some that the only significant differences between individuals in homogenous groupings such as elite athletes can be attributed to psychological differences. The afore-mentioned mental toughness construct is one possible explanation for the differences between those who consistently succeed at elite level, and those who do not.

Other psychological considerations in this regard are those of perceptual-cognitive and perceptual-motor skills inherent to sport. These are valid considerations and ones that have in fact been studied and addressed for decades, with particular interest emanating from the cognitive proponents of expert performance. It can be said unequivocally that this study supports the view underlying the importance of perceptual-cognitive and perceptual-motor skills and abilities and this therefore serves as the conclusion in this regard.

This study successfully incorporated a sport vision test that partly addresses these issues, but it is a recommendation of this study that further in-depth research and evaluation be done of perceptual cognitive, motor and sport vision ability in rugby and in general. There are individuals in South Africa who are currently contributing to this area (Dr. Sherylle Calder), but there is certainly a need for more participation and analysis in this regard.

### 9.2.5 Talent identification

Talent identification is the central theme of this study. The historical development and progress of talent identification and development worldwide and in South Africa was reported in chapter six. Stemming from this analysis, this study greatly endorses the original findings and recommendations of du Randt (1992) and the various sub-sections (du Randt & Headley, 1992b; 1992c; 1992d) as still being valid to this very day.

Furthermore, the modern critiques as well as proposed solutions of both Abbott *et al.* (2007) and Vaeyens *et al.* (submitted) that received extensive review are endorsed. Once again these endorsements serve as a conclusion of this study with the further recommendation being that these factors are considered, *as far as practically and scientifically possible*, in future talent identification approaches. It is recommended that genetic testing, while promising, should rather be observed a while longer before concrete decisions in this regard are made.

Of particular importance to the preceding discussion and the abridged examples presented of the approaches implemented by Canada, Scotland and New Zealand to talent identification and development (in chapter six), is that talent development be considered the primary driver with talent identification serving a supplementary and supporting role. Without being flippant, development develops the (potential) talent that identification strives to identify. A recommendation of this study is that ongoing and broad spectrum talent development is performed within the context of South African sport with talent identification performing a supplementary function in this regard.

#### 9.2.5.1 Talent identification and development in SANZAR

The different approaches of talent identification and development within the SANZAR countries were presented in chapter six. It is not possible to state whether one country's methods are superior to another, since each of the counties have their own inherent strengths and weaknesses associated with their methods and approaches. The conclusion of this study is that within the South African context, the future looks promising and if the systems can be adopted and adapted where necessary into an all-encompassing holistic approach that suits all role-players, South Africa's sustained high level participation in the international rugby arena is guaranteed. The recommendation in this regard is that the research community contribute toward the goals and mission of SARU as much as possible so as to develop and improve systems for talent identification and development.

In conclusion, when considering whether this study has achieved the first aim of providing an in-depth literature review, the answer is affirmative. It is however recommended that further study be undertaken, particularly with regards to talent development and identification and the relative impact that these two approaches have on one another.

## 9.3 CONCLUSIONS AND RECOMMENDATIONS FROM THE EMPIRICAL INVESTIGATION

In adopting an evolutionary approach to the testing protocol as was done in this study, the risks were always going to be high. On the whole, however, while the risks were admittedly high, and while the results can best described as mixed (the skills tests), the results are certainly promising. Furthermore, statistically simulated norms were provided for future comparison.

### 9.3.1 Interviews with coaches and conditioning specialists

The interviews with the coaches and the conditioning specialists served to confirm that the current talent identification approaches in rugby as pioneered by Pienaar and Spamer (1995) in Pienaar and Spamer (1998) and used in various forms in a *large number* of subsequent studies are certainly robust and valid and need very little, if any, modification. What this study attempted from some of the advice garnered from these coaches was to adapt and devise new sport-specific tests that accurately reflect the game-specific environment experienced in rugby. The intention of this study was not to improve upon the preceding tests and protocols, but to provide alternative tests so as to broaden the base of possible tests that could be considered for future evaluation purposes. But, as noted earlier and in summary of this sub-section, the interviews and subsequent elaboration thereupon further emphasised the quality and relevance of the extant literature in the field of talent identification in rugby in South Africa.

### 9.3.2 Test protocol evolution

Subsequent, during and after testing on the three occasions mentioned during the course of chapters seven and eight, certain sport-specific skills tests were discarded, another test was modified and two sport-specific skills tests were retained. These decisions were taken primarily on the basis of the results obtained from practically performing these tests *in conjunction* with factors such as applicability to the sport and practical usage within field testing protocols.

### 9.3.3 Results obtained

As noted on numerous occasions, the results are mixed yet promising. While it is disappointing that so many sport-specific tests had to be discarded, the silver-lining to this is that the tests that remained are robust and valid and that there are now statistically simulated norms for positional groupings.

The specific findings of the anthropometrical, physical-motor, sports specific-skills and sport vision ability as these pertain to the positional groupings can be found in chapter eight of this study. Specific conclusions and recommendations regarding the self-devised tests are provided hereafter:

#### 9.3.3.1 Discarded tests

It is concluded that there were tests that have merit (kick for accuracy-quadrant; push press for strength; Accuvision 1000 “120 lights”) and tests that cannot be described in that way (hooker throw in at 6m, 8m, 10m; scrumhalf tyre test). The kick for accuracy (quadrant) test can certainly be used as a training approach for accuracy kicking. The push press test for strength can and should be used in ascertaining the relative upper-body strength of the lineout lifters, although its ability to test sport specific strength is questionable. The Accuvision1000 “120 lights” test has merit as a laboratory test. These are therefore the associated recommendations for these tests.

#### 9.3.3.2 Final test protocol

It is concluded that the final test protocol for this study adequately achieved the second main aim of this study, i.e.: to provide an alternative sport and position-specific testing protocol as well as comparative results consisting of norms and scores that will adequately identify and select those capable of participating in elite age-group rugby union.

While the anthropometrical tests were pre-existing, one self-devised physical-motor test, i.e.: the 3x5x22m Anaerobic Capacity Test has been successfully established with statistically simulated norms. The sport-specific tests, i.e.: kick for distance and accuracy and the S-Tests were successfully integrated although no statistically simulated norms could be established due to their small base sizes.

It is recommended that further studies be conducted on the kick for distance and accuracy test as well as the S-Tests. The norms for the S-Test fall into four basic categories ranging from bad, poor, average and good. While this might suffice, the recommendation is made that further studies on this test be conducted on elite players to determine the relative ability of these players in this test for future reference. A further recommendation is that the S-Test be included in testing protocols along with the pre-existing tests originally devised by Pienaar and Spamer (1995) in Pienaar and Spamer (1998), since if anything, this study has highlighted the efficacy of these preceding protocols and tests. It is also strongly recommended that the kick for distance and accuracy test be used in future protocols to establish norms for comparison with the same recommendation applying regarding its inclusion with other pre-existing tests.

A further and final recommendation for this study is to utilise this final test protocol in further studies that include a broader sample. Now that the final protocol has been settled upon and the measurements are now standardised across the board, this would enable the current norms (statistically simulated and otherwise) to be validated against similar samples.

## 9.4 CONCLUSIONS AND RECOMMENDATIONS REGARDING STUDY HYPOTHESIS

The hypothesis noted in chapter one is as follows: the findings of this study will contribute meaningfully to elite rugby union by providing sport and position specific test protocols as well as norms and standards for comparison.

It is concluded that this study does in fact contribute to elite rugby union first and foremost by providing a sport-specific test protocol. Secondly, while this protocol is not position specific from no's 1 to 15 in the rugby team, it does provide an indication of the relative abilities needed by grouped positions consisting of the tight-forwards, loose-forwards and backline players. Norms and standards for future comparison have been established.

Therefore, the hypothesis of this study has been achieved.

# BIBLIOGRAPHY


ABBOTT, A. & COLLINS, D. (2002). A theoretical and empirical analysis of a "state of the art" talent identification model. **High Ability Studies,** 13(2):157-178.

ABBOTT, A. & EASSON, B. (2002). The mental profile. In HALE, B.D. & COLLINS, D.J. (Editors). **Rugby Tough.** Human Kinetics Publishers, Inc. pp. 17-34.

ABBOTT, A. & COLLINS, D. (2004). Eliminating the dichotomy between theory and practice in talent identification and development: Considering the role of psychology. **Journal of Sports Sciences,** 22: 395-408.

ABBOTT, A. BUTTON, C. PEPPING, G. J. & COLLINS, D. (2005). Unnatural selection: Talent identification and development in sport. **Nonlinear Dynamics, Psychology and Life Sciences,** 9(1): 61-88.

ABBOTT, A. COLLINS, D. SOWERBY, K. & MARTINDALE, R. (2007). **Developing the Potential of Young People in Sport. A Report for Sportscotland by the University of Edinburgh.** Published Document. http://www.sportscotland.org.uk/ChannelNavigation/Resource+Library/Publications/Developing+the+Potential+of+Young+People+in+Sport.htm.

ABERNETHY, B. & RUSSELL, D.G. (1987). Expert-novice differences in an applied selective attention task. **Journal of Sport Psychology,** 9: 326-345.

ABERNETHY, B. FARROW, D. & BERRY, J. (2003). Constraints and issues in the development of a general theory of expert perceptual-motor performance. In STARKES, J.L. & ERICSSON, K.A. (Editors). **Expert Performance in Sports: Advances in Research on Sport Expertise.** Champaign, Ill. Human Kinetics. pp. 349- 369.

ABERNETHY, B. BAKER, J. & CÔTÉ, J. (2005). Transfer of pattern recall skills may contribute to the development of sport expertise. **Applied Cognitive Psychology,** 19:705-718.

ABERNETHY, B. & CÔTÉ, J. (2007). Nurturing the development of a comprehensive model of expertise. **International Journal of Sport Psychology,** 38:68-72.

ACKERMAN, P.L. & BEIER, M.E. (2003). Trait complexes, cognitive investment, and domain knowledge. In STERNBERG, R.J. & GRIGORENKO, E.L. (Editors). **The Psychology of Abilities, Competencies and Expertise.** Cambridge University Press. pp. 1-30.

ACKLAND, T.R. & BLOOMFIELD, J. (1996). Stability on human proportions through adolescent growth. **Australian Journal of Science and Medicine in Sport,** 28(2): 57-60.

AITKEN, D.A. & JENKINS, D.G. (1998). Anthropometric-based selection and sprint kayak training in children. **Journal of Sports Sciences,** 16: 539-543.

ALI, C. CORNWELL, T.B. NGUYEN, D. & COOTE, L. (2006). Exploring the usefulness of consumer activity in the sponsorship-linked marketing context. **International Journal of Sports Marketing & Sponsorship.** January 2006. 115-124.

ALLARD. F. (1993). Cognition, expertise, and motor performance. In STARKES, J.L. & ALLARD, F. (Editors). **Cognitive Issues in Motor Expertise.** North Holland: Elsevier Science Publishers B.V. pp. 17-34.

AMIRAULT, R.J. & BRANSON, R.K. (2006). Educators and expertise: A brief history of theories and models. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 69- 86.

AMOROSE, A.J. (2001). An examination of the determinants of sport commitment in college athletes. **Research Quarterly for Exercise and Sport.** March 2001 Supplement, A-86.

AMOROSE, A.J. & ANDERSON-BUTCHER, D. (in press). Autonomy-supportive coaching and self-determined motivation in high school and college athletes: A test of self-determination theory. **Psychology of Sport and Exercise.**

ANDERSON, J.R. (2005). **Cognitive Psychology and Its Implications. Sixth Edition.** W.H. Freeman and Company. Worth Publishers.

ANDREW, M. GROBBELAAR, H.W. & POTGIETER, J.C. (2007). Sport psychological skill levels and related psychosocial factors that distinguish between rugby union players of different participation levels. **South African Journal for Research in Sport, Physical Education and Recreation,** 29(1):1-14.

ANGYAN, L. TECZELY, T. ZALAY, Z. & KARSAI, I. (2003). Relationship of anthropometrical, physiological and motor attributes to sport-specific skills. **Acta Physiologica Hungarica,** 90(3):225-231. Abstract.

ARAÚJO, D. DAVIDS, K. BENNETT, S.J. BUTTON, C. & CHAPMAN, G. (2004). Emergence of sport skills under constraints. In WILLIAMS, A.M. & HODGES, N.J. (Editors). **Skill Acquisition in Sport: Research, Theory and Practice.** Routledge. Taylor & Francis Group. London and New York. pp. 409-433.

ARAÚJO, D. (2007). Promoting ecologies where performers exhibit expert interactions. **International Journal of Sport Psychology,** 38:73-77.

BABIĆ, Z. MIŚIGOJ-DURAKOVIĆ, M. MATASIĆ, H. & JANĆIĆ, J. (2001). Croatian rugby project-part 1: Anthropometric characteristics, body composition and constitution. **Journal of Sports Medicine and Physical Fitness,** 41: 250-255.

BAILEY, R. & MORLEY, D. (2006). Towards a model of talent development in physical education. **Sport, Education and Society,** 11(3): 211-230.

BAKER, J. (2001). Genes and training for athletic performance revisited. **Sportscience** 5(2), sportsci.org/jour/0102/jb.htm, 2001 (2032 words). Date Accessed: 09/08/2007.

BAKER, J. (2003). Early specialization in youth sport: A requirement for adult expertise? **High Ability Studies,** 14(1): 85-94.

BAKER, J. CÔTÉ, J. & ABERNETHY, B. (2003a). Sport specific practice and the development of expert decision-making in team ball sports. **Journal of Applied Sport Psychology,** 15:12-25.

BAKER, J. CÔTÉ, J. & ABERNETHY, B. (2003b). Learning from the experts: Practice activities of expert decision makers in sport. **Research Quarterly for Exercise and Sport,** 74(3): 342-348.

BAKER, J. HORTON, S. ROBERTSON-WILSON, J. & WALL, M. (2003c). Nurturing sport expertise: Factors influencing the development of elite athlete. **Journal of Sports Science and Medicine,** 2: 1-9.

BAKER, J. & HORTON, S. (2004). A review of the primary and secondary influences on sport expertise. **High Ability Studies,** 15(2): 211-228.

BAKER, J. DEAKIN, J. & CÔTÉ, J. (2005). On the utility of deliberate practice; predicting performance in ultra-endurance triathletes from training indices. **International Journal of Sport Psychology,** 36:225-240.

BAKER, J. (2007). Nature and nurture interact to create expert performers. **High Ability Studies,** 18(1): 57-58.

BAKER, J. & DAVIDS, K. (2007a). Introduction. **International Journal of Sport Psychology,** 38: 1-3.

BAKER, J. & DAVIDS, K. (2007b). Sound and fury, signifying nothing? Future directions in the nature-nurture debate. **International Journal of Sport Psychology,** 38: 135-143.

BAKER, J. & LOGAN, A.J. (2007). Developmental contexts and sporting success: birth date and birthplace effects in national hockey leagues draftees 2000-2005. **British Journal of Sports Medicine,** 41: 515-517.

BATTISTA, R.A. PIVARNIK, J.M. DUMMER, G.M. SAUER, N. & MALINA, R.M. (2007). Comparisons of physical characteristics and performances among female collegiate rowers. **Journal of Sports Sciences,** 25(6): 651-657.

BEEK, P.J. JACOBS, D.M. DAFFERTSHOFER, A. & HUYS, R. (2003). Expert performance in sport: Views from the joint perspectives of Ecological psychology and Dynamical Systems Theory. In STARKES, J.L. & ERICSSON, K.A. (Editors). **Expert Performance in Sports: Advances in Research on Sport Expertise.** Champaign, Ill. Human Kinetics. pp. 321- 344.

BEELD KOERANT. (2007). **Sport met Miljarde in SA Geborg: Bedryf Groei Jaarliks Met 17%.** Donderdag 19 April 2007:30

BENGOECHEA, E.G. & STREAN, W.B. (2007). On the interpersonal context of adolescents' sport motivation. **Psychology of Sport and Exercise,** 8:195-217.

BERNARDI, M. QUATTRINI, F.M. RODIO, A. FONTANA, G. MADAFARRI, A. BRUGNOLI, M. & MARCHETTI, M. (2007). Physiological characteristics of America's Cup sailors. **Journal of Sports Sciences,** 25(10): 1141-1152.

BEUNEN, G. THOMIS, M. PEETERS, M. MAES, H.H. CLAESSENS, A.L. & VLIETINCK, R. (2003). Genetics of strength and power characteristics in children and adolescents. **Pediatric Exercise Science,** 15 (2): 128-138. Abstract.

BEUNEN, G. & THOMIS, M. (2006). Gene driven power athletes? Genetic variation in muscular strength and power. **British Journal of Sports Medicine,** 40: 822-823.

BLOOM, B.S. (Editor) (1985). **Developing Talent in Young People.** Ballantine Books. New York.

BOCK-JONATHAN, B.B. VENTER, R.E. & BRESSAN, E.S. (2007). A comparison between skill and decision-making ability of netball players at club level: Pilot study. **South African Journal for Research in Sport, Physical Education and Recreation,** 29(1): 29-38.

BOOYSEN, C. (2002). **The Application of Discriminant Analysis and Logistical Regression as Methods of Compilation in the Prediction Function in Youth Rugby.** Unpublished Masters Degree Dissertation. University of Pretoria, Pretoria.

BOUCHARD, C. DAW, E.W. RICE, T. PÉRUSSE, L. GAGNON, J. PROVINCE, M.A. LEON, A.S. RAO, D.C. SKINNER, J.S. & WILMORE, J.H. (1998). Familial resemblance for $VO_2max$ in the sedentary state: The HERITAGE family study. **Medicine & Science in Sports & Exercise,** 30(2): 252-258.

BOUCHARD, C. AN, P. RICE, T. SKINNER, J.S. WILMORE, J.H. GAGNON, J. PÉRUSSE, L. LEON, A.S. & RAO, D.C. (1999). Familial aggregation of $VO_2max$ response to exercise training: Results from the HERITAGE Family Study. **Journal of Applied Physiology,** 87(3): 1003-1008.

BOUCHARD, C. RANKINEN, T. CHAGNON, Y.C. RICE, T. PÉRUSSE, L. GAGNON, J. BORECKI, I. AN, P. LEON, A.S. SKINNER, J.S. WILMORE, J.H. PROVINCE, M. & RAO, D.C. (2000). Genomic scan for maximal oxygen uptake and its response to training in the HERITAGE Family Study. **Journal of Applied Physiology,** 88: 551-559.

BOURGOIS, J. CLAESSENS, A.L. VRIJENS, J. PHILIPPAERTS, R. VAN RENTERGHEM, B. THOMIS, M. JANSSENS, M. LOOS, R. & LEFEVRE, J. (2000). Anthropometric characteristics of elite male junior rowers. **British Journal of Sports Medicine,** 34: 213-217.

BROWN, J. (2001). **Sports Talent: How to Identify and Develop Outstanding Athletes.** Champaign Ill.: Human Kinetics.

BRUSTAD, R.J. BEBKES, M.L. & SMITH, A.L. (2001). Youth in sport. In SINGER, R.N. HAUSENBLAS, H.A. & JANELLE, C.M. (Editors). **Handbook of Sport Psychology.** Second Edition. New York: Wiley. pp.604-635.

BUCHANAN, B.G. DAVIS, R. FEIGENBAUM, E. A. (2006). Expert systems: A perspective from computer science. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 87-103.

BULL, S.J. SHAMBROOK, C.J. JAMES, W. & BROOKS, J.E. (2005). Towards an understanding of mental toughness in elite English cricketers. **Journal of Applied Sport Psychology,** 17:2: 209-227.

BURNETT, C. (2005). Influences on the socialisation of South African elite athletes. **South African Journal for Research in Sport, Physical Education and Recreation,** 27(1): 37-50.

BUTTON, C. & ABBOTT, A. (2007). Nature-nurture and sport performance. **International Journal of Sport Psychology,** 38:83-88.

CALVO, M. RODAS, G. VALLEJO, M. ESTRUCH, A. ARCAS, A. JAVIERRE, C. VISCOR, G. & VENTURA, J.L. (2002). Heritability of explosive power and anaerobic capacity in humans. **European Journal of Applied Physiology,** 86:218-225.

CALDER, S. (2007). Foreword. In COOPER, M. & GOODENOUGH, T. **In the Zone with South Africa's Sports Heroes-How to Achieve Top Performance in Sport and Life.** Zebra Press. pp. xiii-xiv.

CARPENTER, P.J. SCANLAN, T.K. SIMONS, J.P. & LOBEL, M. (1993). A test of the sport commitment model using structural equation modeling. **Journal of Sport & Exercise Psychology,** 15: 119-133.

CARPENTER, P.J. & COLEMAN, R. (1998). A longitudinal study of elite youth cricketers' commitment. **International Journal of Sport Psychology,** 29: 195-210.

CERVELLÓ, E. SANTOS ROSA, F.J. CALVO, T.G. JIMÉNEZ, R. & IGLESIAS, D. (2007). Young tennis players' competitive task involvement and performance: The role of goal orientations, contextual motivational climate, and coach-initiated motivational climate. **Journal of Applied Sport Psychology,** 19: 304-321.

CHANTAL, Y. GUAY, F. DOBREVA-MARTINOVA, T, & VALLERAND, R.J. (1996). Motivation and elite performance: An exploratory investigation with Bulgarian athletes. **International Journal of Sport Psychology,** 27: 173-182.

CHARNESS, N. TUFFIASH, M. KRAMPE, R. REINGOLD, E. & VASYUKOVA, E. (2005). The role of deliberate practice in chess expertise. **Applied Cognitive Psychology,** 19: 151-165.

CHASE, W. G. & SIMON, H.A. (1973a). The mind's eye in chess. In CHASE, W.G. (Editor). **Visual Information Processing.** Academic Press. New York and London. pp. 215-281.

CHASE, W.G. & SIMON, H.A. (1973b). Perception in chess. **Cognitive Psychology,** 4: 55-81.

CIANCIOLO, A.T. MATTHEW, C. STERNBERG, R.J. & WAGNER, R.K. (2006). Tacit knowledge, practical intelligence, and expertise. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 613-632.

COAKLEY, J. (1998). **Sport in Society: Issues and Controversies.** Sixth Edition. WCB/McGraw-Hill.

COAKLEY, J. (2001). **Sport in Society: Issues and Controversies.** Seventh Edition. McGraw-Hill. New York, NY 10020.

COAKLEY, J. (2003). **Sports in Society: Issues and Controversies.** Eighth Edition. McGraw-Hill. New York, NY 10020.

COETZEE, B. PIENAAR, A.E. & COETZEE, M. (2001). Bepaling van talentidentifiseringsdeterminante vir kruipslagswemprestasies by 14 jarige seuns: 'n Kinantropometriese profiel. **Suid Afrikaanse Tydskrif vir Navorsing in Sport, Liggaamlike Opvoedkunde en Ontspanning,** 23(1): 9-25.

COETZEE, Z. COETZEE, M. & BOTHA, K. (2005). Redes vir sportdeelname van hoërskoolleerlinge. **South African Journal for Research in Sport, Physical Education and Recreation.** 27(1): 51-63.

COKER, C.A. (2004). **Motor Learning and Control for Practitioners**. McGraw-Hill.

COLQUHOUN, A. (2006). **Sasol SA Rugby Annual.** 35th Edition. SA Rugby & MWP Media (Pty) Ltd.

COLQUHOUN, A. (2007). **Sasol SA Rugby Annual.** 36th Edition. SA Rugby (Pty) Ltd & MWP Media (Pty) Ltd.

CONLEY, M. (2000). Bioenergetics of exercise and training. In BAECHLE, T.R. & EARLE, R.W. (Editors). **Essentials of Strength Training and Conditioning.** Second Edition. National Strength and Conditioning Association. Champaign, Ill.: Human Kinetics. pp. 73-90.

COOKE, G. (2004). Finding talent by the numbers. **Sports Coach,** 26(4): 19-20.

COOPER, M. (2007). **Personal communication**. Pretoria.

COOPER, M. & GOODENOUGH, T. (2007). **In the Zone With South Africa's Sports Heroes-How to Achieve Top Performance in Sport and Life.** Zebra Press.

CORDASCO, F. (1965). **A Brief History of Education: A Handbook of Information on Greek, Roman, Medieval, Renaissance, and Modern Educational Practice.** Littlefield, Adams & Co. Totowa, New Jersey.

CÔTÉ, J. (1999) The influence of the family in the development of talent in sport. **The Sport Psychologist,** 13(4): 395-417.

CÔTÉ, J. BAKER, J. & ABERNETHY, B. (2003). From play to practice. A developmental framework for the acquisition of expertise in team sports. In STARKES, J.L. & ERICSSON, K.A. (Editors). **Expert Performance in Sports: Advances in Research on Sport Expertise.** Champaign, Ill. Human Kinetics. pp. 89-113.

CÔTÉ, J. MACDONALD, D.J. BAKER, J. & ABERNETHY, B. (2006). When “where” is more important than “when”: Birthplace and birthdate effects on the achievement of sporting expertise. **Journal of Sports Sciences,** 24(10): 1065-1073.

CÔTÉ, J. BAKER, J. & ABERNETHY, B. (2007). Practice and play in the development of sport expertise. In TENENBAUM, G. & EKLUND, R.C. (Editors). **Handbook of Sport Psychology.** Third Edition. John Wiley & Sons, Inc. pp. 184-202.

COX, R.H. (1994). **Sport Psychology: Concepts and Applications.** Third Edition. WCB Brown & Benchmark Publishers.

COX, R.H. & YOO, H.S. (1995). Playing position and psychological skill in American Football. **Journal of Sport Behavior,** 18(3): 183-195.

CRAVEN, D.H. (1974). **Patroon vir rugby: n’ Praktiese Handleiding oor Grondbeginsels, Vaardigheded, Spelsette en Oefenmetodes.** Kaapstad: Tafelberg.

CROMPTON, J.L. (2004). Conceptualization and alternate operationalizations of the measurement of sponsorship effectiveness in sport. **Leisure Studies,** 23(3): 267-281.

CUMMING, S.P. SMOLL, F.L. SMITH, R.E. GROSSBARD, J.R. (2007). Is winning everything? The relative contributions of motivational climate and won-lost percentage in youth sports. **Journal of Applied Sport Psychology,** 19: 322-336.

CUMMINS, R. & CUMMINS, D.D. (2000). (Editors). **Minds, Brains, and Computers. The Foundations of Cognitive Science. An Anthology.** Blackwell Publishers Inc.

DAVIDS, K. (2000). Skill acquisition and the Theory of Deliberate Practice: It aint' what you do it's the way that you do it! **International Journal of Sport Psychology,** 31: 461-466.

DAVIDS, K. LEES, A. & BURWITZ, L. (2000). Understanding and measuring coordination and control in kicking skills in soccer: Implications for talent identification and skill acquisition. **Journal of Sports Sciences,** 18: 703-714.

DAVIDS, K. WILLIAMS, A.M. BUTTON, C. & COURT, M. (2001). An integrative modelling approach to the study of intentional movement behavior. In SINGER, R.N. HAUSENBLAS, H.A. & JANELLE, C.M. (Editors). **Handbook of Sport Psychology.** Second Edition. New York: Wiley. pp.144-173.

DAVIDS, K.D. ARAÚJO, D. BUTTON, C. & RENSHAW, I. (2007). Degenerate brains, indeterminate behavior, and representative tasks: Implications for experimental design in sport psychology research. In TENENBAUM, G. & EKLUND, R.C. (Editors). **Handbook of Sport Psychology.** Third Edition. John Wiley & Sons, Inc. pp. 224-244.

DEAKIN, J.M. & COBLEY, S. (2003). A search for deliberate practice. An examination of the practice environments in figure skating and volleyball. In STARKES, J.L. & ERICSSON, K.A. (Editors). **Expert Performance in Sports:**

**Advances in Research on Sport Expertise.** Champaign, Ill. Human Kinetics. pp. 115-135.

DEAKIN, J.M. CÔTÉ, J. & HARVEY, A.S. (2006). Time, budgets, diaries, and analyses of concurrent practice activities. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 303-318.

DEANS, R. (2006). **Personal communication**. Crusaders Coach: New Zealand Rugby Union.

DECI, E. L. & RYAN, R.M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. **Psychological Inquiry,** 11(4): 1-37.

DE GROOT, A. (1978). **Thought and Choice in Chess** (Original work published in 1946). The Hague: Mouton.

DETTERMAN, D.K. (1993). Giftedness and intelligence: One and the same ? In BOCK, G.R. & ACKRILL, K. (Editors). **The Origins and Development of High Ability.** Ciba Foundation Symposium 178. John Wiley & Sons. pp. 22-43.

DEUTSCH, M.U. MAW, G.J. JENKINS, D. & REABURN, P. (1998). Heart rate, blood lactate and kinematic data of elite colts (under-19) rugby union players during competition. **Journal of Sports Sciences,** 16: 561-570.

DE VILLIERS, P. (2004). **Personal communication**. South Africa U/21 Rugby Coach. Johannesburg.

DE VILLIERS, L. & LE ROUX. J.G. (2005). Die identifisering van sportprestasiefaktore deur die gebruik van regressie-analise. **South African**

**Journal for Research in Sport, Physical Education and Recreation,** 27(1): 65-74.

DUDA, J.L. (1993). Goals: A social-cognitive approach to the study of achievement motivation in sport. In SINGER, R.N. MURPHEY, M. & TENNANT, L.K. (Editors). **Handbook of Research on Sport Psychology.** New York: Macmillan. pp. 421-436.

DUDA, J.L. & HALL, H. (2001). Achievement goal theory in sport: Recent extensions and future directions. In SINGER, R.N. HAUSENBLAS, H.A. & JANELLE, C.M. (Editors). **Handbook of Sport Psychology.** Second Edition. New York: Wiley. pp.417-443.

DUNCAN, M.J. WOODFIELD, L. & AL-NAKEEB, Y. (2006). Anthropometric and physiological characteristics of junior elite volleyball players. **British Journal of Sports Medicine,** 40: 649-651.

DURAND-BUSH, N. & SALMELA, J.H. (2001). The development of talent in sport. In SINGER, R.N. HAUSENBLAS, H.A. & JANELLE, C.M. (Editors). **Handbook of Sport Psychology.** Second Edition. New York: Wiley. pp. 269-289.

DURAND-BUSH, N. & SALMELA, J.H. (2002). The development and maintenance of expert athletic performance: perceptions of world and Olympic champions. **Journal of Applied Sport Psychology,** 14: 154-171.

DU RANDT, R. (Editor). (1992). **Sport Talent Identification and Related Issues in Selected Countries.** Port Elizabeth: University of Port Elizabeth.

DU RANDT, R. & HEADLEY, N. (1992a). Statement of the problem. In DU RANDT, R. (Editor). **Sport Talent Identification and Related Issues in Selected Countries.** Port Elizabeth: University of Port Elizabeth. pp. 1-5.

DU RANDT, R. & HEADLEY, N. (1992b). Conceptual models for sport talent identification and development. In DU RANDT, R. (Editor). **Sport Talent Identification and Related Issues in Selected Countries.** Port Elizabeth: University of Port Elizabeth. pp. 9-24.

DU RANDT, R. & HEADLEY, N. (1992c). Problems in talent identification and development. In DU RANDT, R. (Editor). **Sport Talent Identification and Related Issues in Selected Countries.** Port Elizabeth: University of Port Elizabeth. pp. 233-237.

DU RANDT, R. & HEADLEY, N. (1992d). Guidelines and recommendations. In DU RANDT, R. (Editor). **Sport Talent Identification and Related Issues in Selected Countries.** Port Elizabeth: University of Port Elizabeth. pp. 238-242.

DURANDT, J. DU TOIT, S. BORRESEN, J. HEW-BUTLER, T. MASIMLA, H. JAKOET, I. & LAMBERT, M. (2006). Fitness and body composition profiling of elite junior South African rugby players. **South African Journal of Sport Medicine,** 18(2): 38-45.

DURANDT, J. (2007). **Personal communication**. Sports Science Institute of South Africa (SSISA).

DURNIN, J.V.G.A. & WOMERSLEY, J. (1974). Body fat assessed from total body density and its estimation from skinfold thickness: Measurements in 481 men and women aged from 16 to 72 years. **British Journal of Nutrition,** 32: 77-97.

DUTHIE, G. PYNE, D. & HOOPER, S. (2003). Applied physiology and game analysis of rugby union. **Sports Medicine,** 33(13): 973-991. Abstract.

DUTHIE, G. PYNE, D. & HOOPER, S. (2005). Time motion analysis of 2001 and 2002 Super 12 rugby. **Journal of Sports Sciences,** 23(5): 523-530.

DUTHIE, G.M. (2006). A framework for the physical development of elite rugby union players. **International Journal of Sports Physiology and Performance,** 1:2-13.

DUTHIE, G.M. PYNE, D.B. HOPKINS, W.G. LIVINGSTONE, S. & HOOPER, S.L. (2006a). Anthropometry profiles of elite rugby players: quantifying changes in lean mass. **British Journal of Sports Medicine,** 40: 202-207.

DUTHIE, G.M. PYNE, D.B. MARSH, D.J. & HOOPER, S.L. (2006b). Sprint patterns in rugby union players during competition. **The Journal of Strength and Conditioning Research,** 20(1): 208-214. Abstract.

DU TOIT, P.J. KRÜGER, P.E. DE WET, K.B. VAN VUUREN, B. JOUBERT, A. LOTTERING, M.L. & VAN WYK, G.J. (2006a) Transfer effects of eye-hand co-ordination skills from the right to the left cerebral hemispheres in South African schoolboy rugby players. **African Journal for Physical, Health Education, Recreation and Dance,** 12(1): 41-49.

DU TOIT, P.J. KRÜGER, P.E. DE WET, K.B. VAN VUUREN, B. VAN HEERDEN, H.J. & JANSE VAN RENSBURG, C. (2006b). Influence of exhaustion on metabolism and visual motor performance of professional cricket players. **African Journal for Physical, Health Education, Recreation and Dance,** 12(1): 50-59.

ECCLES, D.W. & TENENBAUM, G. (2004). Why an expert team is more than a team of experts: A social-cognitive conceptualization of team coordination and communication in sport. **Journal of Sport and Exercise Psychology,** 26: 542-560.

ELFERINK-GEMSER, M.T. VISSCHER, C. RICHART, H. & LEMMINK, A.A.P.M. (2004). Development of the tactical skills inventory for sports. **Perceptual and Motor Skills**, 99: 883-895.

ELFERINK-GEMSER, M.T. VISSCHER, C. VAN DUIJN, M.A.J. & LEMMINK, K.A.P.M. (2006). Development of the interval endurance capacity in sub-elite youth field hockey players. **British Journal of Sports Medicine,** 40: 340-345.

ELFERINK-GEMSER, M.T. VISSCHER, C. LEMMINK, K.A.P.M. & MULDER, T. (2007). Multidimensional performance characteristics and standard of performance in talented youth field hockey players: A longitudinal study. **Journal of Sports Sciences,** 25(4): 481-489.

ELOFF, E. (2004). **Personal communication**. Lions Currie Cup Coach. Johannesburg.

ERICSSON, K.A. KRAMPE, R.T. & TESCH-RöMER, C. (1993). The role of deliberate practice in the acquisition of expert performance. **Psychological Review,** 100(3): 363-406.

ERICSSON, K.A. & CHARNESS, N. (1995). Abilities: evidence for talent or characteristics acquired through engagement in relevant activities. **American Psychologist,** 50: 803-804.

ERICSSON, K.A. (Editor). (1996a). **The Road to Excellence: The Acquisition of Expert Performance in the Arts and Sciences, Sports and Games.** Lawrence Erlbaum Associates, Publishers. Mahwah, New Jersey.

ERICSSON, K.A. (1996b). The acquisition of expert performance: An introduction to some of the issues. In ERICSSON, K.A. (Editor). **The Road to Excellence: The Acquisition of Expert Performance in the Arts and Sciences, Sports and Games.** Lawrence Erlbaum Associates, Publishers. Mahwah, New Jersey. pp. 1-50.

ERICSSON, K.A. & LEHMANN, A.C. (1996). Expert and exceptional performance: Evidence on maximal adaptations on task constraints. **Annual Review of Psychology,** 47: 273-305.

ERICSSON, K.A. (2003a). Development of elite performance and deliberate practice: An update from the perspective of the expert performance approach. In STARKES, J.L. & ERICSSON, K.A. (Editors). **Expert Performance in Sports: Advances in Research on Sport Expertise.** Champaign, Ill. Human Kinetics. pp. 49-83.

ERICSSON, K.A. (2003b). How the expert-performance approach differs from traditional approaches to expertise in sports: In search of a shared theoretical framework for studying expert performance. In STARKES, J.L. & ERICSSON, K.A. (Editors). **Expert Performance in Sports: Advances in Research on Sport Expertise.** Champaign, Ill. Human Kinetics. pp. 371-402.

ERICSSON, K.A. (2004). Deliberate practice and the acquisition and maintenance of expert performance in medicine and related domains. **Academic Medicine,** 79(10): S70-S81.

ERICSSON, K.A. (2005). Recent advances in expertise research: A commentary on the contributions to the special issue. **Applied Cognitive Psychology,** 19: 233-241.

ERICSSON, K.A. NANDAGOPAL, K. & RORING, R.W. (2005). Giftedness viewed from the expert-performance perspective. Journal for the Education of the Gifted, 28: 287-311.

ERICSSON, K.A. (2006a). An introduction to *The Cambridge Handbook of Expertise and Expert Performance:* It's development, organization and content. In ERICSSON, CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge**

**Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 3-19.

ERICSSON, K.A. (2006b). Protocol analysis and expert thought; concurrent verbalisations of thinking during expert's performance on representative tasks. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 223-241.

ERICSSON, K.A. (2006c). The influence of experience and deliberate practice on the development of superior expert performance. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 683-703.

ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). (2006). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 3-19.

ERICSSON, K.A. (2007a). Deliberate practice and the modifiability of body and mind: Toward a science of the structure and acquisition of expert and elite performance. **International Journal of Sport Psychology,** 38:4-34.

ERICSSON, K.A. (2007b). Toward a science of expert and exceptional performance in sport: A reply to the commentaries. **International Journal of Sport Psychology,** 38:109-123.

ERICSSON, K.A. RORING, R.W. & NANDAGOPAL, K. (2007a). Giftedness and evidence for reproducibly superior performance: An account based on the exert performance framework. **High Ability Studies,** 18(1): 3-56.

ERICSSON, K.A. RORING, R.W. & NANDAGOPAL, K. (2007b). Misunderstandings, agreements, and disagreements: Toward a cumulative science of reproducibly superior aspects of giftedness. **High Ability Studies,** 18(1): 97-115.

ERIKSSON, M. RASMUSSEN, F. & TYNELIUS, P. (2006). Genetic factors in physical activity and the equal environment assumption-the Swedish Young Male Twins Study. **Behavior Genetics,** 36(2): 238-247.

ESCARTÍ, A. ROBERTS, G.C. CERVELLO, E.M. & GUZMAN, J.F. (1999). Adolescent goal orientations and the perception of criteria of success used by significant others. **International Journal of Sport Psychology,** 30: 309-324.

EVERT, A. (2004). **Personal communication**. General Manager: Blue Bulls Rugby College. Pretoria.

EVERT, A. (2006). **The Significance of Dominant Ball Carrying Collisions as an Indicator of Success in Rugby Union and the Biomechanical Analysis Thereof.** Unpublished D.Phil Dissertation. University of Pretoria, Pretoria.

EYSENCK, H.J. & BARRETT, P.T. (1993). Brain research related to giftedness. In HELLER, K.A. MÖNKS, F.J. & PASSOW, A.H. (Editors). **International Handbook of Research and Development of Giftedness and Talent.** Pergamon Press. pp. 115-131.

FAGARD, R. BIELEN, E. & AMERY, A. (1991). Heritability of aerobic power and anaerobic energy generation during exercise. **Journal of Applied Physiology,** 70(1) : 357-362. Abstract.

FALK, B. LIDOR, R. LANDER, Y. & LANG, B. (2004). Talent identification and early development of elite water polo players: A 2-year follow-up study. **Journal of Sport Sciences,** 22: 347-355.

FEIN, P. (2007). Why tennis is tougher than golf. **Sports Illustrated South Africa.** July, 2007. pp. 96-100

FELTOVICH, P.J. PRIETULA, M.J. & ERCISSON, K.A. (2006). Studies of expertise from psychological perspectives. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 41-67.

FOSS, M.L. & KETEYIAN, S.J. (1998). **Fox's Physiological Basis for Exercise and Sport.** Sixth Edition. WCB McGraw-Hill.

FOURIE, S. & POTGIETER, J.R. (2001). The nature of mental toughness in sport. **S.A. Journal for Research in Sport, Physical Education and Recreation,** 23(2): 63-72.

FRENCH, K.E. & MCPHERSON, S.L. (1999). Adaptations in response selection processes used during sport competition with increasing age and expertise. **International Journal of Sport Psychology,** 30: 173-193.

FRENCH, K.E. SPURGEON, J.H. & NEVETT, M.E. (2007). Anthropometric characteristics of Columbia, South Carolina, youth baseball players and Dixie Youth World Series players. (growth and motor development). **Research Quarterly for Exercise and Sport,** 78(3): 179-189.

GABBARD, C.P. (1992). **Lifelong Motor Development.** Second Edition. Brown & Benchmark Publishers.

GABBETT, T.J. (2002a). Influence of physiological characteristics on selection in a semi-professional first grade rugby league team: A case study. **Journal of Sports Sciences,** 20: 399-405.

GABBETT, T.J. (2002b). Physiological characteristics of junior and senior rugby league players. **British Journal of Sports Medicine,** 36: 334-339.

GABBETT, T.J. (2005). A comparison of physiological and anthropometric characteristics among playing positions in junior rugby league players. **British Journal of Sports Medicine,** 39: 675-680.

GABBETT, T.J. (2006). A comparison of physiological and anthropometric characteristics among playing positions in sub-elite rugby league players. **Journal of Sports Sciences,** 24(12): 1273-1280.

GABBETT, T.J. & GEORGIEFF, B. (2006). The development of a standardized skill assessment for junior volleyball players. **International Journal of Sports Physiology and Performance,** 1: 95-107.

GABBETT, T.J. & DOMROW, N. (in press). Relationships between training load, injury, and fitness in sub-elite collision sport athletes. **Journal of Sports Sciences.**

GABBETT, T.J. GEORGIEFF, B. & DOMROW, N. (in press). The use of physiological, anthropometric, and skill data to predict selection in a talent-identified junior volleyball squad. **Journal of Sports Sciences.**

GAGNÉ, F. (1993). Constructs and models pertaining to exceptional human abilities. In HELLER, K.A. MÖNKS, F.J. & PASSOW, A.H. (Editors). **International Handbook of Research and Development of Giftedness and Talent.** Pergamon Press. pp. 69-87.

GAGNÉ, F. (1998). A biased survey and interpretation of the nature-nurture literature. **Behavioural and Brain Sciences,** 21, 415-416.

GAGNÉ, F. (2007). Predictably, an unconvincing second attempt. **High Ability Studies,** 18(1): 67-69.

GARRAWAY, W.M. LEE, A.J. HUTTON, S.J. RUSSEL, E.B.A.W. & MACLEOD, D.A.D. (2000). Impact of professionalism on injuries in rugby union. **British Journal of Sport Medicine,** 34: 348-351.

GASKILL, S.E. RICE, T. BOUCHARD, C. GAGNON, J. RAO, D.C. SKINNER, J.S. WILMORE, J.H. & LEON, A. (2001). Familial resemblance in ventilatory threshold: The HERITAGE Family Study. **Medicine & Science in Sports & Exercise,** 33(11): 1832-1840.

GELADAS, N. KOSKLOU, M. & KLISSOURAS, V. (2007). Nature-nurture: Not an *either-or* question. **International Journal of Sport Psychology,** 38: 124-134.

GIDDENS, A. (2001). **Sociology. 4th Edition. Fully Revised and Updated.** Polity Press. Blackwell Publishing Company.

GLAMSER, F.D. & VINCENT, J. (2004). The relative age effect among elite American youth soccer players. **Journal of Sport Behaviour,** 27(1): 31-38.

GLAZIER, P.S. DAVIDS, K. & BARTLETT, R.M. (2003). Dynamical Systems Theory: A relevant framework for performance-oriented sports biomechanics research. **Sportscience** 7, sportsci.org/jour/03/psg.htm, 2003 (4063 words). Date Accessed: 09/08/2007.

GOBET, F. (2005). Chunking models of expertise: Implications for education. **Applied Cognitive Psychology,** 19: 183-204.

GOBET, F. & CHARNESS, N. (2006). Expertise in chess. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge**

**Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 523-538.

GOLBY, J. & SHEARD, M. (2004). Mental toughness and hardiness at different levels of rugby league. **Personality and Individual Differences,** 37(5): 933-942.

GOLDSPINK, G. (2003). Gene expression in muscle in response to exercise. **Journal of Muscle Research and Cell Motility,** 24: 121-126.

GORDON, S.E. (1992). Implications of cognitive theory for knowledge acquisition. In HOFFMAN, R.R. (Editor). **The Psychology of Expertise. Cognitive Research and Empirical AI.** Springer-Verlag. pp. 99-120.

GOULD, D. DIEFFENBACH, K. & MOFFETT, A. (2002). Psychological characteristics and their development in Olympic champions. **Journal of Applied Sport Psychology,** 14: 172-204.

GOULD, D. LAUER, L. ROLO, C. JANNES, C. PENNISI, N. (2006). Understanding the role parents play in tennis success: A national survey of junior tennis coaches. **British Journal of Sports Medicine,** 40: 632-636.

GRANT, S.J. OOMMEN, G. MCCOLL, G. TAYLOR, J. WATKINS, L. FRIEL, N. WATT, I. & MCLEAN, D. (2003). The effect of ball carrying method on sprint speed in rugby union football players. **Journal of Sports Sciences,** 21: 1009-1015.

GRASSI, G.P. TURCI, M. SHIRAI, Y.F. SFORZA, C. (2006). Transfer of training for two ball-throwing tasks. **Perceptual and Motor Skills,** 102: 19-28.

GREEN, K. (1998). Philosophies, ideologies and the practice of physical education. **Sport, Education and Society,** 3(2): 125-143.

GRIGORENKO, E.L. (2003). Expertise and mental disabilities. Bridging the unbridgeable? In STERNBERG, R.J. & GRIGORENKO, E.L. (Editors). **The Psychology of Abilities, Competencies, and Expertise.** Cambridge University Press. pp. 156-185.

GUSTAFSON, S.L. & RHODES, R.E. (2006). Parental correlates of physical activity in children and early adolescents. **Sports Medicine,** 36(1): 79-97.

GWYNNE-THOMAS, E.H. (1981). **A Concise History of Education to 1900 A.D.** University Press of America. Lanham-New York-London.

HAHN, A.G. & GROSS. J.B. (1990). Current issues concerning talent identification in Australian sport. **Developing the Young Elite Athlete, Australian Institute of Sport, Canberra,** pp. 1-8.

HALE, B.D. & COLLINS, D.J. (2002). Introduction: Psyching up for rugby. In HALE, B.D. & COLLINS, D.J. (Editors). **Rugby Tough.** Human Kinetics Publishers, Inc. pp. 1-14.

HANSEN, L. BANGSBO, J. TWISK, J. & KLAUSEN, K. (1999). Development of muscle strength in relation to training level and testosterone in young male soccer players. **Journal of Applied Physiology,** 87(3): 1141-1147.

HARE, E. (1999). **Longitudinale Studie van Talentvolle Jeugrugbyspelers met Verwysing na Vaardigheid, Groei en Ontwikkeling.** Ongepubliseerde D. Ed-verhandeling. Potchefstroomse Universiteit vir Christelike Hoër Onderwys, Potchefstroom.

HARMAN, E. GARHAMMER, J. & PANDORF, C. (2000). Administration, scoring, and interpretation of selected tests. In BAECHLE, T.R. & EARLE, R.W. (Editors). **Essentials of Strength Training and Conditioning.** Second Edition. National

Strength and Conditioning Association. Champaign, Ill.: Human Kinetics. pp. 287-318.

HARPENDEN SKINFOLD CALIPER. (2007). http://www.harpenden-skinfold.com/. Date Accessed: 17/08/2007.

HARRIDGE, S.D.R. ANDERSEN, J.L. HARTKOPP, A. ZHOU, S. BIERING-SØRENSEN, S.C. & KJÆR, M. (2002). Training by low-frequency stimulation of tibialis anterior in spinal cord-injured men. **Muscle Nerve,** 25: 685-694.

HATTINGH, J.H.B. (2003). **A Prevention Programme for Rugby Injuries Based on an Analysis Among Adolescent Players.** Ongepubliseerde Ph.D-verhandeling. Potchefstroomse Universiteit vir Christelike Hoër Onderwys, Potchefstroom.

HAWKE, T.J. (2007). Heritability is more than sequence deep. **International Journal of Sport Psychology,** 38: 96-99.

HAZELDINE, R. & MCNAB, T. (1991). **Fit for Rugby.** Kingswood Press.

HELLER, K.A. (1993). Structural tendencies and issues of research on giftedness and talent. In HELLER, K.A. MÖNKS, F.J. & PASSOW, A.H. (Editors). **International Handbook of Research and Development of Giftedness and Talent.** Pergamon Press. pp. 49-67.

HELSEN, W.F. STARKES, J.L. & HODGES, N.J. (1998). Team sports and the theory of deliberate practice. **Journal of Sport and Exercise Psychology,** 20: 12-34.

HELSEN, W.F. & STARKES, J.L. (1999). A multi-dimensional approach to skilled perception and performance in sport. **Applied Cognitive Psychology,** 13: 1-27.

HELSEN, W.F. HODGES, N.J. VAN WINCKEL, J. & STARKES, J.L. (2000). The roles of talent, physical precocity and practice in the development of soccer expertise. **Journal of Sport Sciences,** 18(9): 727-737.

HELSEN, W.F. VAN WINCKEL, J. & WILLIAMS, A.M. (2005). The relative age effect in youth soccer across Europe. **Journal of Sports Sciences,** 23(6): 629-636.

HOARE, D. (1998). Talent search: A review and update. **Sports Coach,** 21(3): 32-35.

HOARE, D.G. (2000). Predicting success in junior elite basketball players-The contribution of anthropometric and physiological attributes. **Journal of Science and Medicine in Sport,** 3(4): 391-405. Abstract.

HOARE, D.G. & WARR, C.R. (2000). Talent identification and women's soccer: An Australian experience. **Journal of Sports Sciences,** 18: 751-758.

HOBERMAN, J. (2007). The origins of peak performance: Motivational and hereditary factors. International Journal of Sport Psychology, 28:100-103

HOCKEY, R.V. (1996). **Physical Fitness: The Pathway to Healthful Living.** Eighth Edition. Mosby-Year Book, Inc.

HODGE, K. & MCKENZIE, A. (2002). Motivation and confidence. In HALE, B.D. & COLLINS, D.J. (Editors). **Rugby Tough.** Human Kinetics Publishers, Inc. pp. 35-59.

HODGES, N.J. & STARKES, J.L. (1996). Wrestling with the nature of expertise: a sport-specific test of Ericsson, Krampe and Tesh-Römer's (1993) theory of "deliberate practice." **International Journal of Sport Psychology,** 27: 400-424.

HODGES, N.J. & FRANKS, I.M. (2004). Instructions, demonstrations and the learning process. In WILLIAMS, A.M. & HODGES, N.J. (Editors). **Skill Acquisition in Sport: Research, Theory and Practice.** Routledge. Taylor & Francis Group. London and New York. pp. 145-174.

HODGES, N.J. KERR, T. STARKES, J.L. WEIR, P.L. & NANANIDOU, A. (2004). Predicting performance times from deliberate practice hours for triathletes and swimmers: What, when, and where is practice important? **Journal of Experimental Psychology: Applied,** 10(4): 219-237.

HODGES, N.J. STARKES, J.L. & MACMAHON, C. (2006). Expert performance in sport: A cognitive perspective. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 471-488.

HODGES, N.J. HUYS, R. & STARKES, J.L. (2007). Methodological review and evaluation of research in expert performance in sport. In TENENBAUM, G. & EKLUND, R.C. (Editors). **Handbook of Sport Psychology.** Third Edition. John Wiley & Sons, Inc. pp.161-183.

HOHMANN A. & SEIDEL, I. (2003). Scientific aspects of talent development. **International Journal of Physical Education,** 40(1): 9-20.

HOLLANDER, W.J. & BURNETT, C. (2002). A social perspective on sport-related trends and careers. **South African Journal for Research in Sport, Physical Education and Recreation,** 24(2): 23-35.

HOPKINS, W.G. (1998). Performance gene discovered. **Sportscience** 2(4), sportsci.org/jour/9804/brief.html#gene, 1998 (475 words). Date Accessed: 09/09/2007.

HOPKINS, W.G. (2001). Genes and training for athletic performance. **Sportscience** 5(1), sportsci.org/jour/0101/wghgene.htm, 2001 (1899 words). Date Accessed: 09/08/2007.

HORE, A. (2007). **Personal communication**. New Zealand Rugby Union.

HOWE, M.J.A. DAVIDSON, J.W. & SLOBODA, J.A. (1998). Innate talents: Reality or myth? **Behavioural and Brain Sciences,** 21: 399-407.

HOWELL, D.C. (1992). **Statistical Methods for Psychology (3rd ed.).** Belmont: Duxbury Press.

HUNT, E. (2006). Expertise, talent and social encouragement. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 31-38.

HUYS, R. DAFFERTSHOFER, A. & BEEK, P.J. (2004). The evolution of coordination during skill acquisition. In WILLIAMS, A.M. & HODGES, N.J. (Editors). **Skill Acquisition in Sport: Research, Theory and Practice.** Routledge. Taylor & Francis Group. London and New York. pp. 351-373.

HYLLEGARD, R. (2005). Factors in athletic achievement: Reply to Van Rossum (2004). **Perceptual and Motor Skills,** 100, 362-264.

HYLLEGARD, R. & YAMAMOTO, M. (2005). Testing assumptions of deliberate practice theory, relevance, effort, and inherent enjoyment of practice on a novel task. **Perceptual and Motor Skills,** 101: 283-294.

JAMES, N. MELLALIEU, S.D. & JONES, N.M. (2005) The development of position-specific performance indicators in professional rugby union. **Journal of Sports Sciences,** 23: 63-72.

JANELLE, C.M. & HILLMAN, C.H. (2003). Expert performance in sport. Current perspectives and critical issues. In STARKES, J.L. & ERICSSON, K.A. (Editors). **Expert Performance in Sports: Advances in Research on Sport Expertise.** Champaign, Ill. Human Kinetics. pp. 19-47.

JODL, K.M. MICHAEL, A. MALANCHUK, O. ECCLES, J.S. & SAMEROFF, A. (2001). Parent's roles in shaping early adolescent's occupational aspirations. **Child Development**, 72(4): 1247-1265.

JOHNSON, M.B. TENENBAUM, G. & EDMONDS, W.A. (2006). Adaptation to physically and emotionally demanding conditions: The role of deliberate practice. **High Ability Studies,** 17(1): 117-136.

JONES, G. HANTON, S. & CONNAUGHTON, D. (2002). What is this thing called mental toughness? An investigation of elite sport performers. **Journal of Applied Sport Psychology,** 14(3): 205-218.

JONES, M. (2003). Losing our late bloomers. Today's youth sports system fails to recognize that children develop at different rates. **Soccer Journal,** 48(3): 19-23.

JONES, G. HANTON, S. & CONNAUGHTON, D. (2007). A framework of mental toughness in the world's best performers. **The Sport Psychologist,** 21: 243-264.

JORDAAN, W. & JORDAAN, J. (1984). **Man in Context.** McGraw-Hill Book Company.

JORDAAN, W. & JORDAAN, J. (1998). **People in Context.** Third Edition. Heinemann Higher & Further Education (Pty) Ltd.

JORDET, G. (2005). Perceptual training in soccer: An imagery intervention study with elite players. **Journal of Applied Sport Psychology,** 17(2): 140-156.

JOUBERT, R. & GROENEWALD, B. (1998). **Principles of Successful Coaching.** Cape Town: SARFU Publication.

JOWETT, S. & MEEK, G.A. (2000a). A case study of a top-level coach-athlete dyad in crisis. **Journal of Sports Sciences,** 18(1): 51. Abstract.

JOWETT, S. & MEEK, G.A. (2000b). The coach-athlete relationship in married couples: An exploratory content analysis. **The Sport Psychologist,** 14(2): 157-175.

JOWETT, S. & COCKERILL, I.M. (2003). Olympic medallist's perspective of the athlete-coach relationship. **Psychology of Sport and Exercise,** 4: 313-331.

KEOGH, J. (1999). The use of physical fitness scores and anthropometric data to predict selection in an elite under 18 Australian Rules football team. **Journal of Science and Medicine in Sport,** 2(2): 125-133.

KEOGH, J.W.L. WEBER, C.L. & DALTON, C.T. (2003). Evaluation of anthropometric, physiological, and skill-related tests for talent identification in female field hockey. **Canadian Journal of Applied Physiology,** 28(3): 397-409.

KLISSOURAS, V. (2001). The nature and nurture of human performance. **European Journal of Sport Science,** 1(2): 1-10.

KLISSOURAS, V. GELADAS, N. & KOSKLOU, M. (2007). Nature prevails over nurture. **International Journal of Sport Psychology,** 38: 35-67.

KLUKA, D.A. (1999). **Motor Behavior: From Learning to Performance.** Morton Publishing Company.

KOENDERMAN, T. (2007). Sports Bucks Still Abound: Billions Spent on Marketing. **Finweek.** 1 March 2007: 58

KRÜGER, P.E. CILLIERS, J.F. & ROSSOUW, F. (2001). Physiological and physical performance qualities of junior rugby players. **African Journal for Physical, Health Education, Recreation and Dance (AJPHERD),** October (Supplement): 53-69.

LAMBERT, M. (2004). Applied exercise science is alive and well in South Africa. **South African Journal of Sports Medicine,** 16(1): 1.

LAU, P.W.C. FOX, K.R. & CHEUNG, M.W.L. (2005). Psychosocial and socio-environmental correlates of sport identity and sport participation in secondary school-age children. **European Journal of Sport Science,** 4(3): 1-21.

LAVIN, E. (2000). The genetics of physical fitness. **British Journal of Sports Medicine,** 34: 154.

LEE, T.D. CHAMBERLIN, C.J. & HODGES, N.J. (2001). Practice. In SINGER, R.N. HAUSENBLAS, H.A. & JANELLE, C.M. (Editors). **Handbook of Sport Psychology.** Second Edition. New York: Wiley. pp. 115-143.

LEHMANN, A.C. & GRUBER, H. (2006). Music. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 457-470.

LIDOR, R. FALK, B. ARNON, M. COHEN, Y. SEGAL, G. & LANDER, Y. (2005). Measurement of talent in team handball: The questionable use of motor and physical tests. **Journal of Strength and Conditioning Research,** 19(2): 318-325.

LIDOR, R, HERSHKO, Y. BILKEVITZ, A. ARNON, M. & FALK, B. (2007). Measurement of talent in volleyball: 15-month follow-up of elite adolescent players. **Journal of Sports Medicine and Physical Fitness,** 47: 159-168.

LOUW, D.A. VAN EEDE, D.M. & LOUW, A.E. (1998). **Human Development.** Second Edition. Kagiso Tertiary.

LUGER, D. & POOK, P. (2004). **Complete Conditioning for Rugby.** Human Kinetics. Champaign, Illinois.

LYOKA, P.A. & BRESSAN, E.S. (2003). Elite coaches' perceptions of the characteristics of decision-making that discriminate between expert and novice basketball players. **South African Journal for Research in Sport, Physical Education and Recreation,** 25(1): 59-69.

MACARTHUR, D.G. & NORTH, K.N. (2005). Genes and human elite athletic performance. **Human Genetics,** 116: 331-339.

MACARTHUR, D.G. & NORTH, K.N. (2007). ACTN3: A genetic influence on muscle function and athletic performance. **Exercise and Sport Sciences Reviews,** 35(1): 30-34.

MACMAHON, C. HELSEN, W.F. STARKES, J.L. & WESTON, M. (2007). Decision-making skills and deliberate practice in elite association football referees. **Journal of Sports Sciences,** 25(1): 65-78.

MAGILL, R.A. (1998). **Motor Learning: Concepts and Applications.** Fifth Edition. WCB McGraw-Hill.

MAHER, A. WILSON, N. SIGNAL, L. THOMSON, G. (2006). **Patterns of sport sponsorship by gambling, alcohol and food companies: An internet survey.** Published Document. http://www.biomedcentral.com/content/pdf/1471-2458-6-95.pdf

MAHON, T. (2004). **Linking Promise to the Podium: Talent Identification and Development (TID) in New Zealand. A Report to SPARC's Board from the TID Taskforce.** Published Document. http://www.sparc.org.nz/Talent-Identification-and-Development.

MALINA, R.M. MELESKI, B.W. & SHOUP, R.F. (1982). Anthropometric, body composition, and maturity characteristics of selected school-age athletes. **Symposium on Sports Medicine,** 19(6): 1305-1323.

MALINA, R.M. & BOUCHARD, C. (1991). **Growth, Maturation, and Physical Activity.** Human Kinetics Books. Champaign, Illinois.

MALINA, R.M. BOUCHARD, C. & BAR-OR, O. (2004a). **Growth, Maturation, and Physical Activity.** Second Edition. Human Kinetics. Champaign, Illinois.

MALINA, R.M. EISENMANN, J.C. CUMMING, S.P. RIBEIRO, B. & AROSO, J. (2004b). Maturity-associated variation in the growth and functional capacities of youth football (soccer) players 13-15 years. **European Journal of Applied Physiology,** 91: 555-562.

MALINA, R.M. CUMMING, S.P. KONTOS, A.P. EISENMANN, B.R. & AROSO, J. (2005). Maturity-associated variation in sport-specific skills of youth soccer players aged 13-15 years. **Journal of Sports Sciences,** 23(5): 515-523.

MALINA, R.M. (2007). Dualism revisited. **International Journal of Sport Psychology,** 38: 104-108.

MALINA, R.M. RIBEIRO, B. AROSO, J. & CUMMING, S. (2007). Characteristics of youth soccer players aged 13-15 years classified by skill level. **British Journal of Sports Medicine,** 41: 290-295.

MALLETT, C.J. & HANRAHAN, S.J. (2004). Elite athletes: Why does the “fire” burn so brightly? **Psychology of Sport and Exercise,** 5: 183-200.

MALLETT, N. (2006). **Personal communication**. Director of rugby: Western Province Rugby Football Union. Cape Town.

MANNING, J.T. & TAYLOR, R.P. (2001). Second to forth digit ratio and male ability in sport: Implications for sexual selection in humans. **Evolution and Human Behavior**, 22: 61-69.

MARFELL-JONES, M. (1996). Essential anatomy for anthropometrists. In NORTON, K. I. & OLDS, T.S. (Editors). **Anthropometrica: A Textbook of Body Measurements for Sports and Health Courses.** UNSW: Sydney, NSW. Australia. pp. 4-24.

MARTINDALE, R.J. COLLINS, D. & DAUBNEY, J. (2005). Talent development: A Guide for practice and research within sport. **Quest,** 57: 353-375.

MARTINDALE, R.J.J. COLLINS, D. & ABRAHAM, A. (2007). Effective talent development: The elite coach perspective in UK sport. **Journal of Applied Sport Psychology,** 19: 187-206.

MASIMLA, H. (2007). **Personal communication**. South African Rugby Union.

MCCARTHY, P.J. JONES, M.V. & CLARK-CARTER, D. (in press). Understanding enjoyment in youth sport: A developmental perspective. **Psychology of Sport and Exercise.**

MCCRORY, P. (2003). Super athletes or gene cheats? **British Journal of Sports Medicine,** 37: 192-193.

MCCRORY, P. (2005). At the sharp end…. **British Journal of Sports Medicine,** 39:1.

MCMORRIS, T. (1999). Cognitive development and the acquisition of decision-making skills. **International Journal of Sport Psychology,** 30: 151-172.

MCPHERSON, S.L. & KERNODLE, M.W. (2003). Tactics, the neglected attribute of expertise: Problem representations and performance skills in tennis. In STARKES, J.L. & ERICSSON, K.A. (Editors). **Expert Performance in Sports: Advances in Research on Sport Expertise.** Champaign, Ill. Human Kinetics. pp. 137-167.

MCPHERSON, S.L. & KERNODLE, M. (2007). Mapping two new points on the tennis expertise continuum: Tactical skills of adult advanced beginners and entry-level professionals during competition. **Journal of Sports Sciences,** 25(8): 945-959.

MEDIC, N. STARKES, J.L. & YOUNG, B.W. (in press). Examining the relative age effects on performance achievement and participation rates in Masters athletes. **Journal of Sports Sciences.**

MEIR, R. (2005). Conditioning the visual system: A practical perspective on visual conditioning in rugby football. **Strength and Conditioning Journal,** 27(4): 86-92.

MIAH, A. & RICH, E. (2006). Genetic tests for ability?: Talent identification and the value of an open future. **Sport, Education and Society,** 11(3): 259-273.

MILLAR, S. (2006). Rugby's development journey continues. In MORGAN, P. & GRIFFITHS, J. (Editors). **IRB World Rugby Yearbook 2007.** Jonathan Ball Publishers. pp. 4-5.

MITCHELL, J. (2004). The case for revolution in school sports. **Journal of the Philosophy of Sport,** XXXI: 64-67.

MONTGOMERY, H. (2000). Author's reply. **British Journal of Sports Medicine,** 34: 154.

MORGAN, T.L. & GIACOBBI, P.R. (2006). Toward two grounded theories of the talent development and social support process of highly successful collegiate athletes. **The Sport Psychologist,** 20: 295-313.

MORRIS, T. (2000). Psychological characteristics and talent identification in soccer. **Journal of Sports Sciences,** 18: 715-726.

MURCIA, J.A.M. GIMENO, E.C. & COLL, D.G. (2007a). Measuring self-determination motivation in a physical fitness setting: Validation of the Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2) in a Spanish sample. **Journal of Sports Medicine and Physical Fitness,** 47: 366-374.

MURCIA, J.A.M. GIMENO, E.C. & COLL, D.G. (2007b). Young athlete's motivational profiles. **Journal of Sports Science and Medicine,** 6: 172-179.

MUSCH, J. & GRONDIN, S. (2001). Unequal competition as an impediment to personal development: A review of the relative age effect in sport. **Developmental Review,** 21: 147-167.

MYBURGH, D. (1998). **The Identification and Development of Swimming Talent.** Unpublished Masters Degree Dissertation. University of Pretoria, Pretoria.

NIEUWENHUIS, C.F. SPAMER, E.J. & VAN ROSSUM, J.H.A. (2002). Prediction function for identifying talent in 14-to 15-year-old female field hockey players. **High Ability Studies,** 13(1): 21-33.

NORDIN, S.M. CUMMING, J. VINCENT, J. & MCGRORY, S. (2006). Mental practice or spontaneous play? Examining which types of imagery constitute deliberate practice in sport. **Journal of Applied Sport Psychology,** 18: 345-362.

NORMAN, G. EVA, K. BROOKS, L. & HAMSTRA, S. (2006). Expertise in medicine and surgery. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 339-353.

NORTON, T. (1982). Hookers. In VODANOVICH, I. & COATES, P. (Editors). **Rugby: Skill and Tactics.** Auckland: Landsdown Press. pp. 64-69.

NORTON, K. WHITTINGHAM, N. CARTER, L. KERR, D. GORE, C & MARFELL-JONES, M. (1996). Measurement techniques in anthropometry. In NORTON, K. I. & OLDS, T.S. (Editors). **Anthropometrica: A Textbook of Body Measurements for Sports and Health Courses.** UNSW: Sydney, NSW. Australia. pp. 25-75.

OERTER, R. (2003). Biological and psychological correlates of exceptional performance in development. **Annals New York Academy of Sciences,** 999: 451-460.

OLDS, T. (2001). The evolution of physique in male rugby union players in the twentieth century. **Journal of Sports Sciences,** 19: 253-262.

OLIVIER, S.C. & COETSEE, M.F. (2002). Tests for predicting endurance in kayak performance. **South African Journal for Research in Sport, Physical Education and Recreation,** 24(2): 45-53.

OLLIS, S. MACPHERSON, A. & COLINS, D. (2006). Expertise and talent development in rugby refereeing: An ethnographic enquiry. **Journal of Sports Sciences,** 24(3): 309-322.

OMAR-FAUZEE, M.S. CHING, J.L. & SALIKON, R.H. (2007). Leadership and psychological roles of female coaches in sports and physical education. **African Journal for Physical, Health Education, Recreation and Dance,** 13(1): 59-70.

OXFORD TALKING DICTIONARY. (1998). **The Learning Company, Inc.** Oxford University Press.

PAPADOPOULOS, C. KALAPOTHARAKOS, V.I. GANTIRAGA, E. NOUSSIOS, G. & GISSIS, I. (2006). Laboratory strength measures of talented and less talented Greek children ages 9 to 10 years. **Perceptual and Motor Skills,** 102: 239-246.

PAPAIOANNOU, A.G. AMPATZOGLOU, G. KALOGIANNIS, P. & SAGOVITS, A. (in press). Social agents, achievement goals, satisfaction and academic achievement in youth sport. **Psychology of Sport & Exercise.**

PARISI, P. CASINI, B. DI SALVO, V, PIGOZZI, F. PITTALUGA, M. PRINZI, G. & KLISSOURAS, V. (2001). The *Registry of Italian Twin Athletes* (RITA): Background, design, and procedures, and twin data analysis on sport participation-an application to twin swimmers. **European Journal of Sport Science,** 1(2): 1-12.

PAUL, S.N. KATO, B.S. HUNKIN, J.L. VIVEKANANDAN, S. SPECTOR, T.D. (2006). The big finger: The second to fourth digit ratio is a predictor of sporting ability in women. **British Journal of Sports Medicine,** 40: 981-983.

PAUOLE, K. MADOLE, K. GARHAMMER, J. LACOURSE, M. & ROZENEK, R. (2000). Reliability and validity of the T-Test as a measure of agility, leg power, and leg speed in college-aged men and women. **The Journal of Strength and Conditioning Research,** 14(4): 443-450. Abstract.

PEARL, B. & MORAN, G.T. (1986). **Getting Stronger: Weight Training for Men and Women.** Bill Pearl and Shelter Publications, Inc.

PEARSON, D.T. NAUGHTON, G.A. & TORODE, M. (2006). Predictability of physiological testing and the role of maturation in talent identification for adolescent team sports. **Journal of Science and Medicine in Sport,** 9(4): 277-287.

PEETERS, M.W. THOMIS, M.A. MAES, H.H.M. BEUNEN, G.P. LOOS, R.J.F. CLAESSENS, A.L. & VLIETINCK, R. (2005). Genetic and environmental determination of tracking in static strength during adolescence. **Journal of Applied Physiology,** 99: 1317-1326.

PÉRUSSE, L. LORTIE, G. LEBLANC, C. TREBLAY, A. THÉRIAULT, G. & BOUCHARD, C. (1987). Genetic and environmental sources of variation in physical fitness. **Annals of Human Biology,** 14(5): 425-434.

PÉRUSSE, L. GAGNON, J. PROVINCE, M.A. RAO. D.C. WILMORE, J.H. LEON, A.S. BOUCHARD, C. & SKINNER, J.S. (2001). Familial aggregation of submaximal aerobic performance in the HERITAGE Family Study. **Medicine & Science in Sport & Exercise,** 33(4): 597-604.

PESCE, C. TESSITORE, A. CASELLA, R. PIRRITANO, M. & CAPRANICA, L. (in press). Focusing on visual attention at rest and during physical exercise in soccer players. **Journal of Sports Sciences.**

PHILIPPAERTS, R.M. VAEYENS, R. JANSSENS, M. VAN RENTERGHEM, B. MATTHYS, D. CRAEN, R. BOURGOIS, J. VRIJENS, J. BEUNEN, G. & MALINA, R.M. (2006). The relationship between peak height velocity and physical performance in youth soccer players. **Journal of Sports Sciences,** 24(3): 221-230.

PHILIPPE, R.A. & SEILER, R. (2006). Closeness, co-orientation and complementarity in coach-athlete relationships: What male swimmers say about their male coaches. **Psychology of Sport and Exercise,** (7): 159-171.

PIENAAR, A.E. & SPAMER E.J. (1996a). A scientific approach towards the identifying of rugby talent among ten and eleven year-old boys. **Kinesiology,** 28(1): 48-53.

PIENAAR, A.E. & SPAMER, E.J. (1996b). Motoriese en fisieke vermoëns van 10-jarige seuns met en sonder vorige ervaring in rugby. **Suid Afrikaanse Tydskrif vir Navorsing in Sport, Liggaamlike Opvoedkunde en Ontspanning,** 19(1&2): 91-99.

PIENAAR, A.E. & SPAMER, E.J. (1998). A longitudinal study of talented young rugby players as regards their rugby skills, physical and motor abilities and anthropometric data. **Journal of Human Movement Studies,** 34: 013-032.

PIENAAR, A.E. SPAMER, E.J. & STEYN, H.S. (1998). Identifying and developing rugby talent among 10-year-old boys: A practical model. **Journal of Sports Sciences,** (16): 691-699.

PIENAAR, A.E. SPAMER, M.J. & PRETORIUS, J.H. (2000). Veranderlikes wat onderskei tussen suksesvolle en minder suksesvolle tienjarige rugbyspelers in geselekteerde spelspesifieke posisies. **S.A. Journal for Research in Sport, Physical Education and Recreation,** 22(2): 23-35

PLOTZ, A.F. & SPAMER, M.J. (2006). A comparison of talented South African and English youth rugby players with reference to game-specific-, anthropometric-, physical and motor variables. **South African Journal for Research in Sport, Physical Education and Recreation,** 28(1): 101-107.

POCZWARDOWSKI, A. BAROTT, J.E. & JOWETT, S. (2006). Diversifying approaches to research on athlete-coach relationships. **Psychology of Sport and Exercise,** 7: 125-142.

POOL, G. (1997). **Modern Rugby: The Essential Concepts and Skills.** Cape Town: Tafelberg Publishers.

POTGIETER, J.R. (1992). Psycho-social perspective on talent identification and development. In DU RANDT, R. (Editor). **Sport Talent Identification and Related Issues in Selected Countries.** Port Elizabeth: University of Port Elizabeth. pp. 54-62.

POULSEN, A.A. ZIVIANI, J.M. & CUSKELLY, M. (in press). General self-concept and life satisfaction for boys with differing levels of physical coordination: the role of goal orientations and leisure participation. **Human Movement Science.**

PRIOR, S.J. HAGBERG, J.M. PHARES, D.A. BROWN, M.D. FAIRFULL, L. FERRELL, R.E. & ROTH, S.M. (2003). Sequence variation in hypoxia-inducible factor 1α (HIF1A): Association with maximal oxygen consumption. **Physiol Genomics,** 15: 20-26.

PYNE, D.B. GARDNER, A.S. SHEEHAN, K. & HOPKINS, W.G. (2006). Positional differences in fitness and anthropometric characteristics in Australian football. **Journal of Science and Medicine in Sport,** 9: 143-150.

QUARRIE, K.L. HANDCOCK, P. TOOMEY, M.J. & WALLER, A.E. (1996). The New Zealand rugby injury and performance project. IV: Anthropometric and physical performance comparisons between position categories of Senior A rugby players. **British Journal of Sports Medicine,** 30:53-56.

QUARRIE, K.L. & WILSON, B.D. (2000). Force production in the rugby union scrum. **Journal of Sports Sciences,** 18: 237-246.

QUARRIE, K.L. ALSOP, J.C. WALLER, A.E. BIRD, Y.N. MARSHALL, S.W. & CHALMERS, D.J. (2001). The New Zealand rugby injury and performance project. VI. A prospective cohort study of risk factors for injury in rugby union football. **British Journal of Sports Medicine,** 35: 157-166.

QUARRIE, K.L. GIANOTTI, S.M. HOPKINS, W.G. & HUME, P.A. (2007). **Effect of nationwide injury prevention programme on serious spinal injuries in New Zealand rugby union: Ecological study.** Published Document. http://www.bmj.com/cgi/reprint/334/7604/1150

QUARRIE, K.L. & HOPKINS, W.G. (2007). Changes in player characteristics and match activities in Bledisloe Cup rugby union from 1972-2004. **Journal of Sports Sciences,** 25(8): 895-903.

REBER, A.S. (1985). **The Penguin Dictionary of Psychology.** Penguin Books.

REES, T. & FREEMAN, P. (2007). The effects of perceived and received support on self-confidence. **Journal of Sports Sciences,** 25(9):1057-1065.

RÉGNIER, G. SALMELA, J. & RUSSELL, S.J. (1993). Talent detection and development in sport. In SINGER, R.N. MURPHEY, M. & TENNANT, L.K. (Editors). **Handbook of Research on Sport Psychology.** New York: Macmillan. pp. 290-313.

REILLY, T. BANGSBO, J. & FRANKS, A. (2000a). Anthropometric and physiological predispositions for elite soccer. **Journal of Sports Sciences,** 18: 669-683.

REILLY, T. WILLIAMS, A.M. NEVILL, A. & FRANKS, A. (2000b). A multi-disciplinary approach to talent identification in soccer. **Journal of Sports Sciences,** 18: 695-702.

REILLY, T. & GILBOURNE, D. (2003). Science and football: A review of applied research in the football codes. **Journal of Sports Sciences,** 21: 693-705.

RICHWALD, S. & PETERSEN, K. (2003). Understanding the path to the podium. **Olympic Coach,** 14, (2): 4-8.

ROBERTS, G.C. (Editor). (2001a). **Advances in Motivation in Sport and Exercise.** Second Edition. Champaign, Il: Human Kinetics.

ROBERTS, G.C. (2001b). Understanding the dynamics of motivation in physical activity: The influence of achievement goals on motivational processes. In ROBERTS, G.C. (Editor). **Advances in Motivation in Sport and Exercise.** Second Edition. Champaign, Il: Human Kinetics. pp. 1-50.

ROBERTS, G.C. TREASURE, D.C. & CONROY, D.E. (2007). Understanding the dynamics of motivation in sport and physical activity: An achievement goal interpretation. In TENENBAUM, G. & EKLUND, R.C. (Editors). **Handbook of Sport Psychology.** Third Edition. John Wiley & Sons, Inc. pp.3-30.

ROBINSON, M. (2006). Personal correspondence. New Zealand Rugby Union.

ROSENBAUM, D.A. AUGUSTYN, J.S. COHEN, R.G. & JAX, S.A. (2006). Perceptual-motor expertise. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J.

& HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 505-520.

ROSNOW, R.L. & ROSENTHAL, R. (1996). **Beginning Behavioural Research: A Conceptual Primer.** New Jersey: Prentice Hall.

ROWLEY, S.R.W. & GRAHAM, P.J. (1999). Intensive training in youth sport: An example of unequal opportunity. **Children & Society,** 13: 119-129.

RUTHERFORD, D. (1983). **International Rugby: For Players, Coaches and Spectators.** London: Heinenmann.

SAVELSBERGH, G.J.P. VAN DER KAMP, J. OUDEJANS, R.R.D. & SCOTT, M.A. (2004). Perceptual learning is mastering perceptual degrees of freedom. In WILLIAMS, A.M. & HODGES, N.J. (Editors). **Skill Acquisition in Sport: Research, Theory and Practice.** Routledge. Taylor & Francis Group. London and New York. pp. 374-389.

SAVULESCU, J. & FODDY, B. (2005). Comment: Genetic test available for sports performance. **British Journal of Sports Medicine,** 39: 472.

SCANLAN, T.K. CARPENTER, P.J. SCHMIDT, G.W. SIMONS, J.P. & KEELER, B. (1993a). An introduction to the sport commitment model. **Journal of Sport & Exercise Psychology,** 15: 1-15.

SCANLAN, T.K. SIMONS, J.P. CARPENTER, P.J. SCHMIDT, G.W. & KEELER, B. (1993b). The sport commitment model: Measurement development for the youth-sport domaln **Journal of Sport & Exercise Psychology,** 15: 16-38.

SCHRAAGEN, J. M. (2006). Task analysis. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 185-201.

SCHUMAN, L. BESTER, G. & LE ROUX, J.G. (2005). The perceptions of coaches and athletes/players of motivation. **South African Journal for Research in Sport, Physical Education and Recreation,** 27(1): 143-152.

SELLENGER, B. (2003). Genetic testing: the future of athlete selection? **Virginia Sports and Entertainment Law Journal,** 2(2): 207-253.

SELLERS, C. (2003). Psychology for high-level performances. **Olympic Coach,** 14(2): 1-3.

SERFONTEIN, N. (2007). **Personal communication**. Blue Bulls Rugby Union.

SHARP, C. (2000). The genetics of physical fitness. **British Journal of Sports Medicine,** 34: 403.

SHERAR, L.B. BAXTER-JONES, A.D.G. FAULKNER, R.A. & RUSSELL, K.W. (2007). Do physical maturity and birth date predict talent in male youth ice hockey players. **Journal of Sports Sciences,** 25(8): 879-886.

SHERIDAN, H. PASVEER, B. & VAN HILVOORDE, I. (2006). Gene-talk and sport-talk: A view from the radical middle ground. **European Journal of Sport Science,** 6(4): 223-230.

SIEGEL, M. (2001). Counteracting tobacco motor sports sponsorship as a promotional tool: Is the tobacco settlement enough? **American Journal of Public Health,** 91(7): 1100-1106.

SIGELMAN, C.K. & RIDER, E.A. (2006). **Life-Span Human Development.** Thomson Wadsworth.

SIMON, H.A. & CHASE, W.G. (1973). Skill in Chess. **American Scientist,** 61: 394-403.

SIMONTON, D.K. (1999). Talent and its development: An emergenic and epigenetic model. **Psychological Review,** 106(3): 435-457.

SIMONTON, D.K. (2001). Talent development as a multidimensional, multiplicative, and dynamic process. **Current Directions in Psychological Science,** 10(2): 39-43.

SIMONTON, D.K. (2005). Giftedness and genetics: The emergenic-epigenetic model and its implications**. Journal for the Education of the Gifted,** 28: 270-286.

SIMONTON, D.K. (2006). **Talent Development in the Sciences: Conceptual Definitions, Distinctions, and Dimensions.** Identifying and developing talent in STEM: A planning meeting, National Academy of the Sciences, September 25-26: 1-13.

SIMONTON, D.K. (2007). Talent and expertise: The empirical evidence for genetic endowment. **High Ability Studies,** 18(1): 83-84.

SINGH, P.C. (2005). “Extreme” parents and sport: A socio-legal perspective. **South African Journal for Research in Sport, Physical Education and Recreation,** 27(2): 83-99.

SINGER, R.N. (2000). Performance and human factors: Considerations about cognition and attention for self-paced and externally paced events. **Ergonomics,** 43(10): 1661-1680.

SINGER, R.N. MURPHEY, M. & TENNANT, L.K. (Editors). (1993). **Handbook of Research on Sport Psychology.** New York: Macmillan.

SINGER, R.N. & JANELLE, C.M. (1999). Determining sport expertise: From genes to supremes. **International Journal of Sport Psychology,** 30: 117-150.

SINGER, R.N. HAUSENBLAS, H.A. & JANELLE, C.M. (Editors). (2001). **Handbook of Sport Psychology.** Second Edition. New York: Wiley.

SLATER, G.J. DUTHIE, G.M. PYNE, D.B. & HOPKINS, W.G. (2006). Validation of a skinfold based index for tracking proportional changes in lean mass. **British Journal of Sports Medicine,** 40: 208-213.

SMEETON, N.J. WARD, P. & WILLIAMS, A.M. (2004). Do pattern recognition skills transfer across sports? A preliminary analysis. **Journal of Sports Sciences,** 22(2): 205-213.

SMIT, G.J. (1986). **Psigometrika, Aspekte van Toetsgebruik.** (3rd ed.) Pretoria: Opvoedkundige Uitgewers.

SMIT, K. (2007). **The Complete Book of Springbok Rugby Records.** Don Nelson Publishers. Cape Town.

SMITH, W. (2002). Foreword: The mindset of a champion. In HALE, B.D. & COLLINS, D.J. (Editors). **Rugby Tough.** Human Kinetics Publishers, Inc. pp. ix-xi.

SMITH, A.L. (2003a). Peer relationships in physical activity contexts: A road less travelled in youth sport and exercise psychology research. **Psychology of Sport and Exercise,** 4: 25-39.

SMITH, D.J. (2003b). A framework for understanding the training process leading to elite performance. **Sports Medicine,** 33(15): 1103-1126.

SMITH, J. (2006a). **The Little Book of English Rugby.** Green Umbrella Publishing.

SMITH, R.E. (2006b). Understanding sport behavior: A cognitive-affective processing systems perspective. **Journal of Applied Sport Psychology,** 18: 1-27.

SOBERLAK, P. & CÔTÉ, J. (2003). The developmental activities of elite ice hockey players. **Journal of Applied Sport Psychology,** 15: 41-49.

SPAMER, E.J. (1999). Talent identification in sport: A present-day perspective with reference to South Africa. **African Journal for Physical, Health Education, Recreation and Dance,** 5(2): 69-95.

SPAMER, E.J. & WINSLEY, R. (2003a). A comparative study of British and South African 12yr old rugby players, in relation to game-specific, physical, motor and anthropometric variables. **Journal of Human Movement Studies,** 44: 37-45.

SPAMER, E.J. & WINSLEY, R. (2003b). Comparative characteristics of elite English and South African 18-year-old rugby-players with reference to game-specific skills, physical abilities and anthropometric data. **Journal of Human Movement Studies,** 45: 187-196.

SPAMER, E.J. & DE LA PORT, Y. (2006). Anthropometric, physical, motor, and game-specific profiles of elite U 16 and U 18 year-old South African Schoolboy Rugby Players. **Kinesiology,** 38:176-184.

STAMM, R. STAMM, M. & THOMSON, K. (2005). Role of adolescent female volleyball players' psychophysiological properties and body build in performance of different elements of the game. **Perceptual and Motor Skills,** 101(1): 108-120.

STARKES, J.L. (1993). Motor experts: Opening thoughts. In STARKES, J.L. & ALLARD, F. (Editors). **Cognitive Issues in Motor Expertise.** North Holland: Elsevier Science Publishers B.V. pp. 3-16.

STARKES, J.L. DEAKIN, J.M. ALLARD, F. HODGES, N.J. & HAYES, A. (1996). Deliberate practice in sports: What is it anyway? In ERICSSON, K.A. (Editor). **The Road to Excellence: The Acquisition of Expert Performance in the Arts and Sciences, Sports and Games.** Lawrence Erlbaum Associates, Publishers. Mahwah, New Jersey. pp. 81-106.

STARKES, J.L. (2000). The road to expertise: Is practice the only determinant? **International Journal of Sport Psychology,** 31: 431-451.

STARKES, J.L. HELSEN, W. & JACK, R. (2001). Expert performance in sport and dance. In SINGER, R.N. HAUSENBLAS, H.A. & JANELLE, C.M. (Editors). **Handbook of Sport Psychology.** Second Edition. New York: Wiley. pp.174-201.

STARKES, J.L. (2003). The magic and the science of sport expertise: Introduction to sport expertise and this volume. In STARKES, J.L. & ERICSSON, K.A. (Editors). **Expert Performance in Sports: Advances in Research on Sport Expertise.** Champaign, Ill. Human Kinetics. pp. 3-15.

STARKES, J.L. & ERICSSON, K.A. (Editors). (2003). **Expert Performance in Sports: Advances in Research on Sport Expertise.** Champaign, Ill. Human Kinetics.

STARKES, J.L. CULLEN, J.D. & MACMAHON, C. (2004). A life-span model of the acquisition and retention of expert perceptual-motor performance. In WILLIAMS, A.M. & HODGES, N.J. (Editors). **Skill Acquisition in Sport: Research, Theory and Practice.** Routledge. Taylor & Francis Group. London and New York. pp. 259-281.

STARKES, J.L. (2007). Plus ça change, plus c'est la même chose. **International Journal of Sport Psychology,** 38: 89-95.

ST CLAIR GIBSON, A. & NOAKES, T.D. (2004). Evidence for complex system integration and dynamic neural regulation of skeletal muscle recruitment during exercise in humans. **British Journal of Sports Medicine,** 38: 797-806.

STEEDMAN, M. (1998). Cognitive algorithms: Questions of representation and computation in building a theory. In SCARBOROUGH, D. & STERNBERG, S. (Editors). **Methods, Models, and Conceptual Issues. An Invitation to Cognitive Science.** A Bradford Book. The MIT Press. pp. 173-210.

STOTLAR, D.K. (1993). **Successful Sport Marketing.** Brown & Benchmark. Wm. C Brown Communications.

STUELCKEN, M. PYNE, D. & SINCLAIR, P. (2007). Anthropometric characteristics of elite cricket fast bowlers. **Journal of Sports Sciences,** 25(14): 1587-1587.

SUMMERS, J.J. (2004). A historical perspective on skill acquisition. In WILLIAMS, A.M. & HODGES, N.J. (Editors). **Skill Acquisition in Sport: Research, Theory and Practice.** Routledge. Taylor & Francis Group. London and New York. pp. 1-26.

TABACHNICK, B.G. & FIDELL, L.S. (1996). **Using Multivariate Statistics.** (3rd ed.). Northridge: Harper Collins College Publishers.

TANNENBAUM, A.J. (1993). History of giftedness and “gifted education” in world perspective. In HELLER, K.A. MÖNKS, F.J. & PASSOW, A.H. (Editors). **International Handbook of Research and Development of Giftedness and Talent.** Pergamon Press. pp. 3-27.

TENENBAUM, G. LEVI-KOLKER, N. SADE, S. LIEBERMAN, D. & LIDOR, R. (1996). Anticipation and confidence of decisions related to skilled performance. **International Journal of Sport Psychology,** 27: 293-307.

TENENBAUM, G. TEHAN, G. STEWART, G. & CHRISTENSEN, S. (1999). Recalling a floor routine: The effects of skill and age on memory for order. **Applied Cognitive Psychology,** 13: 101-123.

TENENBAUM, G. (2003). Expert athletes. An integrated approach to decision making. In STARKES, J.L. & ERICSSON, K.A. (Editors). **Expert Performance in Sports: Advances in Research on Sport Expertise.** Champaign, Ill. Human Kinetics. pp. 191-218.

TENENBAUM, G. & EKLUND, R.C. (Editors). (2007). **Handbook of Sport Psychology.** Third Edition. John Wiley & Sons, Inc.

TENENBAUM, G. & HUTCHINSON, J.C. (2007). A social-cognitive perspective of perceived and sustained effort. In TENENBAUM, G. & EKLUND, R.C. (Editors). **Handbook of Sport Psychology.** Third Edition. John Wiley & Sons, Inc. pp. 560-577.

TERBLANCHE, P.J. (2004). **Personal communication**. Strength and conditioning specialist: Blue Bulls Rugby Union. Pretoria.

THELWELL. R. WESTON, N. & GREENLESS, I. (2005). Defining and understanding mental toughness within soccer. **Journal of Applied Sport Psychology,** 17:4: 326-332.

THOMAS, K.T. GALLAGHER, J.D. & THOMAS, J.R. (2001). Motor development and skill acquisition during childhood and adolescence. In SINGER, R.N. HAUSENBLAS, H.A. & JANELLE, C.M. (Editors). **Handbook of Sport Psychology.** Second Edition. New York: Wiley. pp.20-52.

TRANCKLE, P. & CUSHION, C.J. (2006). Rethinking giftedness and talent in sport. **Quest,** 58(2): 265-286.

TREASURE, D.C. CARPENTER, P.J. & POWER, K.T.D. (2000). Relationship between achievement goal orientations and the perceived purposes of playing rugby union for professional and amateur players. **Journal of Sports Sciences,** 18: 571-577.

TRENT, R.J. & ALEXANDER, I.E. (2006). Gene therapy in sport. **British Journal of Sports Medicine,** 40: 4-5.

TSIMEAS, P.D. TSIOKANOS, A.L. KOUTEDAKIS, Y. TSIGILIS, N. & KELLIS, S. (2005). Does living in urban or rural settings affect aspects of physical fitness in children? An allometric approach. **British Journal of Sports Medicine,** 39: 671-674.

TURNBULL, R. COETZEE, D. & MCDONALD, T. (1995). **Rugby Fitness Testing & Training: A Scientific Approach for Coaches, Fitness Trainers and Players.** City Printing Works, Pietermaritzburg.

ULLRICH-FRENCH, S. & SMITH, A.L. (2006). Perceptions of relationships with parents and peers in youth sport: Independent and combines prediction of motivational outcomes. **Psychology of Sport and Exercise,** 7: 193-214.

UNKNOWN AUTHOR. (2005). **Conrad Jantjes: Man of Many Sports.** http://www.mg.co.za/articlePage.aspx?articleid=235584&area=/breaking_news/breaking_news__sport/. Date Accessed: 30/06/07.

UNKNOWN AUTHOR. (2007a). **Canadian Sports Centres. Long Term Athlete Development.** http://www.ltad.ca/content/home.asp. Date Accessed: 17/08/2007.

UNKNOWN AUTHOR. (2007b) **Canadian Sports Centres. Long Term Athlete Development.**http://www.ltad.ca/Content/Overview/Sport%20System%20Alignment%20and%20Integration.asp. Date Accessed: 17/08/2007.

UNKNOWN AUTHOR. (2007c). **Herschelle Gibbs Official Website.** http://www.bigstarcricket.com/bs/players/gibbs/on_sport.shtml. Date Accessed: 30/06/2007.

UNKNOWN AUTHOR. (2007d). **Jonty Rhodes**-Wikipedia, the free encyclopedia. http://en.wikipedia.org/wiki/Jonty_Rhodes. Date Accessed: 30/06/07.

UNKNOWN AUTHOR. (2007e). **Little Book of the Rugby World Cup: The Greatest Show on Earth.** Green Umbrella Publishing.

UNKNOWN AUTHOR. (2007f). **Rugby.** Murray Books. Australia.

UNKNOWN AUTHOR (2007g). **Tough being a tennis dad.** http://www.news24.com/News24/Sport/Tennis/0,,2-9-1517_2144469,00.html. Date Accessed: 10/07/2007.

VAEYENS, R. COUTTS, A. & PHILIPPAERTS, R.M. (2005a). Evaluation of the "under-21 rule": Do young adult soccer players benefit? **Journal of Sports Sciences,** 23(10): 1003-1013.

VAEYENS, R. PHILIPPAERTS, R.M. & MALINA, R.M. (2005b). The relative age effect in soccer: A match-related perspective. **Journal of Sports Sciences,** 23(7): 747-756.

VAEYENS, R. MALINA, R.M. JANSSENS, M. VAN RENTERGHEM, B. BOURGOIS, J. VRIJENS, J. & PHILIPPAERTS, R.M. (2006). A multidisciplinary selection model for youth soccer: The Ghent youth soccer project. **British Journal of Sports Medicine,** 40: 928-934

VAEYENS, R. LENOIR, M. WILLIAMS, A.M. MAZYN, L. & PHILIPPAERTS, R.M. (2007). The effects of task constraints on visual search behavior and decision-making skill in youth soccer players. **Journal of Sport & Exercise Psychology,** 29: 147-169.

VAEYENS, R. LENOIR, M. WILLIAMS, A.M. & PHILIPPAERTS, R.M. (submitted). Talent identification and development programmes in sport: Current models. **Sport Medicine (invited review).**

VALLERAND, R.J. (2001). A hierarchical model of intrinsic and extrinsic motivation in sport and exercise. In ROBERTS, G.C. (Editor). **Advances in Motivation in Sport and Exercise.** Second Edition. Champaign, Il: Human Kinetics. pp. 263-319.

VALLERAND, R.J. & ROUSSEAU, F.L. (2001). Intrinsic and extrinsic motivation in sport and exercise: A review using the hierarchical model of intrinsic and extrinsic motivation. In SINGER, R.N. HAUSENBLAS, H.A. & JANELLE, C.M. (Editors). **Handbook of Sport Psychology.** Second Edition. New York: Wiley. pp.389-416.

VALLERAND, R.J. (2007). Intrinsic and extrinsic motivation in sport and physical activity: A review and a look at the future. In TENENBAUM, G. & EKLUND, R.C. (Editors). **Handbook of Sport Psychology.** Third Edition. John Wiley & Sons, Inc. pp.59-83.

VAN DER MERWE, F.J.G. (1994). **Sportgeskiedenis.** Stellenbosch: FJG Publikasies.

VAN DER WALT, T.S.P. & DE RIDDER, J.H. (1992). Antropometriese perspektief ten opsigte van talent identifisering en ontwikkeling. In DU RANDT, R. (Editor). **Sport Talent Identification and Related Issues in Selected Countries.** Port Elizabeth: University of Port Elizabeth. pp. 63-85.

VAN GENT, M.M. (2003). **A Test Battery for the Determination of Positional Requirements in Adolescent Rugby Players.** Ongepubliseerde Ph.D-verhandeling. Potchefstroomse Universiteit vir Christelike Hoër Onderwys, Potchefstroom.

VAN GENT, M.M. & SPAMER, E.J. (2005). Comparisons of positional groups in terms of anthropometric, rugby-specific skills, physical and motor components among U 12, U 16, U 18 and U 19 elite rugby players. **Kinesiology,** 37:50-63

VAN GOG, T. PAAS, F. & VAN MERRIËNBOER, J.J.G. (2005). Uncovering expertise-related differences in troubleshooting performance: Combining eye movement and concurrent verbal protocol data. **Applied Cognitive Psychology,** 19: 205-221.

VAN ROSSUM, J.H.A. (1995). **Talent in sport: Significant others in the career of top-level Dutch athletes.** Nurturing talent: Individual needs and social ability: the Fourth Conference of the European Council for High Ability: 43-57.

VAN ROSSUM, J.H. & GAGNÉ, F. (2005). Talent development in sports. In DIXON, F.A. & MOON, S.M. (Editors). **The Handbook of Secondary Gifted Children.** Waco: Prufrock Press. pp. 281-316.

VAZOU, S. NTOUMANIS, N. & DUDA, J.L. (2006). Predicting young athlete's motivational indices as a function of their perceptions of the coach- and peer-created climate. **Psychology of Sport and Exercise,** 7: 215-233.

VENTER, K & MARÉ, Q. (2005). **To Improve the Effect of Fatigue on Peripheral Vision, Peripheral Awareness, Dynamic Vision, Pro-Action Time, Reaction Time and Visual Concentration in Rugby Union Players on High School Level.** Unpublished Honours Degree Dissertation. University of Pretoria, Pretoria.

WALSH, M. YOUNG, B. HILL, B. KITTREDGE, K. & HORN, T. (2007). The effect of ball-carrying technique and experience on sprinting in rugby union. **Journal of Sports Sciences,** 25(2): 185-192.

WARD, P. & WILLIAMS, A.M. (2003). Perceptual and cognitive skill development in soccer: The multidimensional nature of expert performance. **Journal of Sport & Exercise Psychology,** 25(1): 93-111.

WARD, P. HODGES, N.J. WILLIAMS, A.M. & STARKES, J.L. (2004). Deliberate practice and expert performance: Defining the path to excellence. In WILLIAMS, A.M. & HODGES, N.J. (Editors). **Skill Acquisition in Sport: Research, Theory and Practice.** Routledge. Taylor & Francis Group. London and New York. pp. 231-258.

WARD, P. WILLIAMS, A.M. & HANCOCK, P.A. (2006). Simulation for performance and training. In ERICSSON, K.A. CHARNESS, N. FELTOVICH, P.J. & HOFFMAN, R.R. (Editors). **The Cambridge Handbook of Expertise and Expert Performance.** Cambridge University Press. pp. 243-262.

WATTS, J. (2002). Perspectives on sport specialization. **Journal of Physical Education, Recreation & Dance,** 73(8): 32-50.

WEINBERG, R.S. & GOULD, D. (2003). **Foundations of Sport and Exercise Psychology.** Third Edition. Champaign, IL: Human Kinetics.

WEISS, W.M. & WEIS, M.R. (2007). Sport commitment among competitive female gymnasts: a developmental perspective. **Research Quarterly for Exercise and Sport,** 78(2): 90-103.

WHALEY, D.E. (2007). A lifespan developmental approach to studying sport and exercise behaviour. In TENENBAUM, G. & EKLUND, R.C. (Editors). **Handbook of Sport Psychology.** Third Edition. John Wiley & Sons, Inc. pp. 645-661.

WHITE, R.A. (1982) Locks. In VODANOVICH, I. & COATES, P. (Editors). **Rugby: Skill and Tactics.** Auckland: Landsdown Press. pp. 70-73.

WHITE, J. (2004). **Personal communication**. Springbok Rugby Coach. Johannesburg.

WHITAKER, B. (2007). **Personal communication**. Australian Rugby Union.

WILLIAMS, A.M. DAVIDS, K. BURWITZ, L. & WILLIAMS, J.G. (1994). Visual search strategies in experienced and inexperienced soccer players. **Research Quarterly for Exercise and Sport,** 65(2): 127-135.

WILLIAMS, A.M. & DAVIDS, K. (1998). Visual search strategy, selective attention, and expertise in soccer. **Research Quarterly for Exercise and Sport,** 69(2): 111-128.

WILLIAMS, A.M. (2000). Perceptual skill in soccer: Implications for talent identification and development. **Journal of Sports Sciences,** 18: 737-750.

WILLIAMS, A.M. & REILLY, T. (2000a). Editorial: Searching for the stars. **Journal of Sports Sciences,** 18: 655-656.

WILLIAMS, A.M. & REILLY, T. (2000b). Talent identification and development in soccer. **Journal of Sports Sciences,** 18: 657-667.

WILLIAMS, A.M. (2002). Editorial: Visual search behaviour in sport. **Journal of Sports Sciences,** 20: 169-170.

WILLIAMS, A.M. & WARD, P. (2003). Perceptual expertise: Development in sport. In STARKES, J.L. & ERICSSON, K.A. (Editors). **Expert Performance in Sports: Advances in Research on Sport Expertise.** Champaign, Ill. Human Kinetics. pp. 219-249.

WILLIAMS, A.M. WARD, P. & CHAPMAN, C. (2003). Training perceptual skill in field hockey: Is there transfer from the laboratory to the field? **Research Quarterly for Exercise and Sport,** 74: 98-104.

WILLIAMS, A.M. & HODGES, N.J. (Editors). (2004). **Skill Acquisition in Sport: Research, Theory and Practice.** Routledge. Taylor & Francis Group. London and New York.

WILLIAMS, A.M. WARD, P. & SMEETON, N.J. (2004). Perceptual and cognitive expertise in sport: Implications for skill acquisition and performance enhancement. In WILLIAMS, A.M. & HODGES, N.J. (Editors). **Skill Acquisition in Sport: Research, Theory and Practice.** Routledge. Taylor & Francis Group. London and New York. pp. 328-347.

WILLIAMS, A.M. (2005). Editorial: Extending scientific knowledge through the study of sport and exercise psychology. **Journal of Sports Sciences,** 23: 225-226.

WILLIAMS, A.M. & ERICSSON, K.A. (2005). Perceptual-cognitive expertise in sport: Some considerations when applying the expert performance approach. **Human Movement Science** 24: 283-307.

WILLIAMS, A.M. & HODGES, N.J. (2005). Practice, instruction and skill acquisition in soccer: Challenging tradition. **Journal of Sports Sciences,** 23, 637-651.

WILLIAMS, A.M. & RICHARDSON, D. (2006). The key to the World Cup: Environmental influences on the development of expertise. **International Council for Sport and Physical Education Bulletin,** 47: 36-48.

WILLIAMS, A.M. & WARD, P. (2007). Anticipation and decision making: Exploring new horizons. In TENENBAUM, G. & EKLUND, R.C. (Editors). **Handbook of Sport Psychology.** Third Edition. John Wiley & Sons, Inc. pp. 203-223.

WILSON, P.M. RODGERS, W.M. CARPENTER, P.J. HALL, C. HARDY, J. & FRASER, S.N. (2004). The relationship between commitment and exercise behavior. **Psychology of Sport and Exercise,** 4: 405-421.

WILSON, K.M. HARDY, L. & HARWOOD, C.G. (2006). Investigating the relationship between achievement goals and process goals in rugby union players. **Journal of Applied Sport Psychology,** 18: 297-311.

WOLFARTH, B. BRAY, M.S. HAGBERG, J.M. PÉRUSSE, L. RAURAMAA, R. RIVERA, M.A. ROTH, S.M. RANKINEN, T. & BOUCHARD, C. (2005). The human gene map for performance and health-related fitness phenotypes: The 2004 update. **Medicine & Science in Sports & Exercise,** 37(6): 881-903.

WOLFENDEN, L.E. & HOLT, N.L. (2005). Talent development in elite junior tennis: Perceptions of players, parents, and coaches. **Journal of Applied Sport Psychology,** 17: 108-126.

WOLSTENCROFT, E. (Editor) (2002). **Talent Identification and Development: An Academic Review. A Report for sportscotland by The University of Edinburgh.** Published Document. http://www.sportscotland.org.uk/ChannelNavigation/Resource+Library/Publications/Talent+Identification+and+Development+Programme.htm.

WRISBERG, C.A. (1993). Levels of performance. In SINGER, R.N. MURPHEY, M. & TENNANT, L.K. (Editors). **Handbook of Research on Sport Psychology.** New York: Macmillan. pp. 61-72.

WRISBERG, C. A. (2001). Levels of performance skill: From beginners to experts. In SINGER, R.N. HAUSENBLAS, H.A. & JANELLE, C.M. (Editors). **Handbook of Sport Psychology.** Second Edition. New York: Wiley. pp. 3-19.

WUEST, D.A. & BUCHER, C.A. (2006). **Foundations of Physical Education, Exercise Science and Sport.** McGraw-Hill.

YANG, N. MACARTHUR, D.G. GULBIN, J.P. HAHN, A.G. BEGGS, A.H. EASTEAL, S. & NORTH, K. (2003). ACTN3 Genotype is associated with human elite athletic performance. **American Journal of Human Genetics,** 73: 627-631.

YOUNG, W. MCLEAN, B. & ARDAGNA, J. (1995). Relationship between strength qualities and sprinting performance. **Journal of Sports Medicine and Physical Fitness,** 35(1): 13-19.

YOUNG, W.B. JAMES, R. MONTGOMERY, I. (2002). Is muscle power related to running speed with change of direction? **Journal of Sports Medicine and Physical Fitness,** 42(3): 282-288.

YOUNG, W.B. & PRYOR, L. (2007). Relationship between pre-season anthropometric and fitness measures and indicators of playing performance in elite junior Australian Rules football. **Journal of Science and Medicine in Sport,** 10: 110-118.

YUN DAI, D. & COLEMAN, L.J. (2005). Introduction to the special issue on nature, nurture, and the development on exceptional competence. **Journal for the Education of the Gifted,** 28: 254-269.

ZOUDJI, B. & THON, B. (2003). Expertise and implicit memory: Differential repetition priming effects on decision making in experienced and inexperienced soccer players. **International Journal of Sport Psychology,** 34: 189-207.

# APPENDIX A

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

**<u>Questionnaire Pertaining to Talent Identification Structures in South African/New Zealand/Australian Rugby</u>**

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South Africa

**Proposed Research Title:**
Designing a protocol and comparative norms for the identification and selection of talent among elite age-group rugby players in South Africa.

**Purpose of Study:**
The purpose of this study is to evaluate revised testing protocols that have been modified from pre-existing test protocols that have been designed to identify talent in rugby players.

**Note:**
This questionnaire serves the sole purpose of determining the talent identification (TID) structures within South Africa/New Zealand/Australian Rugby. Kindly discuss/list/describe the specific tests and approaches to TID within South Africa/New Zealand/Australia as they are listed below.

While it would be helpful to know if norms and standards are used as forms of comparison, no specific norms and standards are requested for the purposes of this study.

All information provided to me will be used for the purposes of contrasting and comparing TID structures used within the SANZAR nations of South Africa, New Zealand and Australia.

Your assistance in this regard is highly appreciated.

Yours truly,

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

## 1) GENERAL

**1.1) Is TID performed country-wide? Please describe.**

**1.2) At what age-groups is TID officially performed? Please describe. A) Are tests and measurements performed at all levels including junior national, senior national, junior provincial, senior provincial and Super12/14?**

**1.3) Are the obtained results compared to a database containing norms and standards? Please describe. A) Please provide the name of the database used.**

**1.4) Can the results obtained from testing one age-group or group be objectively compared to the results obtained from testing another age-group or group? Please describe.**

**1.5) Who performs TID for the Rugby in South Africa/New Zealand/Australia? A) Is it done "in-house" or are these duties contracted out? B) If they are contracted out then to what organization are these duties assigned?**

**1.6) Regardless of the above questions, please provide a general description of how TID is performed in South African/New Zealand/Australian Rugby addressing any factors or issues not queried above.**

**Continued below…**

**2) Testing Procedures and Protocols**

**2.1) At this juncture a copy of the test protocol used by South African/New Zealand/Australian Rugby would be highly appreciated.**

**A) If this is not possible, would you please describe in general terms the test protocol used by South African/New Zealand/Australian Rugby below?**

**Please indicate whether the following categories i.e.: anthropometrical, physical-motor and skills tests are used or if these tests are performed under other descriptions.**

________________________________________________________________

**B) Are any other tests or categories included that are not mentioned above?**

________________________________________________________________

**2.2) Please list and describe the specific TID anthropometrical tests used in South Africa/New Zealand/Australia.**

**Anthropometrical tests=body mass, body height, fat % etc.**

________________________________________________________________

**2.3) Please list and describe the specific TID physical motor tests used in South Africa/New Zealand/Australia.**

**Physical motor=speed, agility, explosive power etc.**

**2.4) Please list and describe the specific TID rugby skills tests used in South Africa/New Zealand/Australia.**

**Rugby skills tests=passing, kicking etc.**

**2.5) Are the TID rugby skill tests used in South Africa/New Zealand/Australia measured in a qualitative or quantitative manner?**

**Qualitative=perceptions (ranked poor to excellent)**
**Quantitative=measurements (assigning a score of 0/10 or 8/10)**

**2.6) Are the TID rugby skills tests position specific or divided into general and specific skills categories? Please describe.**

**2.7) Are there any other TID tests used in South African/New Zealand/Australian Rugby that have not been mentioned above?**

________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________

**2.8) Is there anything else re: TID in South African/New Zealand/Australian Rugby that you would like to mention or discuss?**

________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________
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________________________________________________________________________________
________________________________________________________________________________

**Continued below…**

**3) TALENT DEVELOPMENT**

**3.1) Once someone has been identified as talented or gifted, what is done to develop this individual further? Please describe.**

**3.2) What talent development and improvement structures are in place in South African/New Zealand/Australian Rugby? Please describe.**

**3.3) Is there anything else re: talent development in South African/New Zealand/Australian Rugby that you would like to mention or discuss?**

**End of document.**

**APPENDIX B**

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

# INTERVIEW FORM FOR D-PHIL STUDY-CONRAD BOOYSEN

The purpose of this form is to help with assessing positional attributes felt to make a major difference in successful rugby playing at a high level. The general premise has been included with space provided for comments by the respective interviewee. Many of the statements have been adapted for the use in this study, with the reference included in brackets at the bottom.

Please note that although the information contained below is factually totally accurate, the statements that have been quoted are not exact or precise as found in the original documentation.

**TIGHT FORWARD PLAY:**

1) Tight forward play consists mostly out of the following:

- Rucks, mauls, line-outs, scrums, to attack and to defend (Craven, 1974; Van Gent, 2003).
- To keep and secure possession of the ball (Hare 1997, in Van Gent, 2003).

Additions:

- _______________
- _______________
- _______________

2) NB components of tight forwards are: the correct body build and length, they must be strong, have speed and high endurance (Craven, 1974; Hazeldine & McNab, 1991; Pool, 1997; Van Gent, 2003).

Additions:

- _______________
- _______________
- _______________

**1) PROPS:**

1) Props, along with the hookers, are responsible for securing possession of the ball in the rucks, mauls and scrums (Craven, 1974; Van Gent, 2003).

Additions:

- _______________
- _______________
- _______________

**Skills:**

- They are the basis of line-outs and scrums (set pieces) (Van Gent, 2003).
- Primary components: proper support of jumpers in line-outs and effective scrumming (Joubert & Groenewald, 1998; Van Gent, 2003)

- Apply pressure on the opposition's scrum and retain own ball in scrum (Rutherford, 1983; Van Gent, 2003).
- Effective in the loose play in giving to the backs good ball and getting over the advantage line (Crave, 1974; Van Gent, 2003).
- Must have good ball handling skills (Van der Merwe, 1989 in Van Gent, 2003).
- Kicking skills? (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ______________
- ______________
- ______________

**Physical Motor:**

- Require power and strength to compete in set pieces and loose play (Hare, 1997 in Van Gent, 2003)
- Able to resist pressure in scrums with static and general strength in arms legs, back and neck (Craven, 1974; Hare, 1997 in Van Gent, 2003; Hazeldine & McNab, 1991).
- Must possess a high work rate and be mobile (Joubert & Groenewald, 1998; Van Gent, 2003).
- Must possess a good base of endurance (Van der Merwe, 1989 in Van Gent, 2003).
- Fast and fit? (Van Gent, 2003).

Additions:

- ______________
- ______________
- ______________

**Psychological Factors and Vision/Anticipation/Reading of Game:**

- ______________
- ______________
- ______________

**2) HOOKERS:**

**Skills:**

- The hooker is a specialist position (throwing in line-out and hooking in scrum) (Hare, 1997 in Van Gent, 2003; Pool, 1997)
- Most important line-out player and must be consistent with throw-ins (Pool, 1997; Van Gent, 2003).
- Must have good ball handling skills for line-outs (Van Gent, 2003).
- Ball handling and tackling (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ______________

- ________________
- ________________

**Physical Motor:**

- Strong (Pool, 1997; Van Gent, 2003).
- Strong legs, back and neck (Craven, 1974; Van Gent, 2003).
- Require a fast reaction and leg speed in open games, as well as powerful legs for rucks, mauls and scrums (Nicholas, 1997 in Van Gent, 2003).
- Good reflexes and strength and good technique in binding in scrums (Norton, 1982).
- Good reactions for hooking in scrums (Van Gent, 2003).
- Hookers must be agile with some suppleness (Norton, 1982; Van Gent, 2003).
- Static and general strength in arms, legs, back and neck as well as muscle endurance and power (Craven, 1974; Hare, 1997 in Van Gent, 2003; Hazeldine & McNab, 1991).
- Fourth loose forward? Hare, 1997 in van Gent, 2003)?
- High endurance levels (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ________________
- ________________
- ________________

**Psychological Factors and Vision/Anticipation/Reading of Game:**

- ________________
- ________________
- ________________

**3) LOCKS:**

**Skills:**

- Ability to scrum and to catch balls in line-out (Pool, 1997; Van Gent, 2003).
- Must fight for ball possession in the line-out (Quarrie *et al.,* 1996; Van Gent, 2003).
- Ball handling and tackling (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ________________
- ________________
- ________________

**Physical Motor:**

- Mobile, strong and agile (White, 1982; Van Gent, 2003).
- Body length important, but overall strength is more significant than body size (White, 1982; Van Gent, 2003).

- To catch balls in mid-air during kick-offs and line-outs, proper balance and hand-eye coordination is needed (Van Gent, 2003).
- Weight and power are needed to successfully compete in loose-play and scrums (Bell, 1980 in Van Gent, 2003).
- Jumping ability is an important (Quarrie *et al.,* 1996; Van Gent, 2003).
- Require arm, leg, back and neck strength (Craven, 1974; Hazeldine & McNab, 1991; Van Gent, 2003).
- Strength and power in scrums (White, 1982).
- They need power to drive into mauls and rucks (Van Gent, 2003).
- Power and weight are advantageous in scrums (Craven, 1974; Hare, 1997 in Van Gent, 2003).
- Speed is an asset (Craven, 1974; Van Gent, 2003).
- Speed endurance required (Van der Merwe, 1989 in Van Gent, 2003).

Additions:
- ______________
- ______________
- ______________

**<u>Psychological Factors and Vision/Anticipation/Reading of Game:</u>**
- ______________
- ______________
- ______________

**<u>LOOSE FORWARD PLAY:</u>**
1) Loose forwards operate in tandem or in combination. They keep the ball in play and secure possession from the opponents. Skill, speed and strength are emphasised (Pool, 1997; Van Gent, 2003).

2) They are quick over short distances and are effective in defence. They have a height advantage over the front rowers but are shorter than the locks. In loose play they are tasked with securing and keeping possession of the ball of (Quarrie, *et al.,* 1996; Van Gent, 2003). Van Gent (2003) says that to be effective in these roles they require mobility, power, endurance and acceleration in open play.

3) They require power and strength to participate in the rucks, mauls and scrums as well as for effective defence (Nicholas, 1997 in Van Gent, 2003).

Additions:
- ______________
- ______________
- ______________

**<u>4) FLANKERS:</u>**
**<u>Skills:</u>**

- Should be forward playing (Pool, 1997; Van Gent, 2003).
- Effective defenders able to stop the opposition (Hanekom, 2000 in Van Gent, 2003).
- Must be good defenders and ball handlers (Van Gent, 2003).
- Are considered vital in rucks and mauls (Hanekom, 2000 in Van Gent, 2003)
- Must possess handling, tackling, running, and ground skills (Van der Merwe, 1989 in Van Gent, 2003)

Additions:

- ______________
- ______________
- ______________

**Physical Motor:**

- Speed (Craven, 1974; Van Gent, 2003).
- They need agility since they are the link between the backs and forwards in broken play (Van Gent, 2003).
- They frequently change directions and need enough speed to get to the mauls and rucks first (Hanekom, 2000 in Van Gent, 2003).
- Require good speed endurance (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ______________
- ______________
- ______________

**Psychological Factors and Vision/Anticipation/Reading of Game:**

- ______________
- ______________
- ______________

**5) EIGHTH MEN:**

**Skills:**

- This is a specialist position in which proper judgement, such as playing the ball or keeping it in the scrum is needed (Pool, 1997; Van Gent, 2003).
- Must be good jumpers at the back of the line-out and must be effective on blind side scrum defence and are utilised in attacking movements from the side of the scrum (Bell, 1980, in Van Gent, 2003).
- They require good ball handling skills since they are the initiators of driving play as opposed to mauls and rucks (Pool, 1997; Van Gent, 2003)
- Together with scrumhalf, the eighth man initiates offensive plays around scrum and are also responsible for cross-defence (Van Gent, 2003)
- Must possess handling, tackling, running, and ground skills (Van der Merwe, 1989, in Van Gent, 2003)

Additions:

- ________________
- ________________
- ________________

**Physical Motor:**

- Must possess agility, power, muscle endurance, strength and speed. They are also faster than other forwards (Hare, 1997 in Van Gent, 2003).
- Must have good speed endurance (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ________________
- ________________
- ________________

**Psychological Factors and Vision/Anticipation/Reading of Game:**

- ________________
- ________________
- ________________

**INSIDE BACK PLAY:**

1) Inside backs utilise the possession that is obtained by the forwards and they decide how this possession is used, i.e.: defensive or offensive moves (Van Gent, 2003).

2) They need to be fast and be able to accelerate away from the rucks, mauls, scrums and line-outs. Endurance is important for the positional play of these players, for the cover defence or for player support (Nicholas, 1997 in Van Gent, 2003).

Additions:

- ________________
- ________________
- ________________

**6) SCRUM-HALVES:**

**Skills:**

- They need to have good ball handling skills and should be able to pass quickly and accurately to both the left and the right sides. They are the link between the back-line and the forwards (Pool, 1997; Van Gent, 2003).
- Must kick well (De Ridder, 1993 in Van Gent, 2003; Joubert & Groenewald, 1998) and possess good decision-making ability, such as when to pass or kick, when to break, or when to continue playing with the forwards (Pool, 1997; Joubert & Groenewald, 1998; Van Gent, 2003).

- Good defence, ball handling and decision making (Rutherford, 1983; Joubert & Groenewald, 1998; Van Gent, 2003).
- Must possess handling, tackling, running, and ground skills (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ________________
- ________________
- ________________

**Physical Motor:**

- They need agility and speed (Van Gent, 2003).
- They require acceleration from the scrum and bi-lateral coordination (Hare, 1997 in Van Gent, 2003).
- Dynamic arm strength ensures accurate and effective passing (Hare, 1997 in Van Gent, 2003).
- Endurance and speed are essential (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- _________________
- _________________
- _________________

**Psychological Factors and Vision/Anticipation/Reading of Game:**

- _______________
- _______________
- _______________

**7) FLY-HALVES:**

**Skills:**

- Must be able to read opposition play, be able to receive and pass balls effectively and rapidly and must have solid kicking skills with both feet in either attacking or defensive situations (Pool, 1997; Van Gent, 2003).
- Require good leadership skills and knowledge of the game to effectively call plays and distribute the ball (Van Gent, 2003).
- Need good side-step, acceleration and running skills (Craven, 1974; Van Gent, 2003).
- They must be defensively solid (Rutherford, 1983; Van Gent, 2003).
- The responsibility of converting penalties and tries lies mostly with them, and therefore they must be specialist goal kickers (Rutherford, 1983; Van Gent, 2003).
- Must possess running, kicking and tackling skills (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ____________________
- ____________________
- ____________________

**Physical Motor:**

- Agility, speed, alertness and quickness are needed (Craven, 1974; Rutherford, 1983; Van Gent, 2003).
- Should rapidly be able to return to position after passing the ball, to provide support to the forwards (Van Gent, 2003).
- Power, speed, strength and agility are needed (Hare, 1997 in Van Gent, 2003).
- Endurance and speed endurance are needed (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ____________________
- ____________________
- ____________________

**Psychological Factors and Vision/Anticipation/Reading of Game:**

- _______________
- _______________
- _______________

**BACK-LINE PLAY:**

1) Must posses speed and good ball handling skills and must know when and how to use both as needed (Van Gent, 2003).

2) Motor capacities such as muscle endurance and aerobic capacity are on the whole better than forwards (Babic *et al.,* 2001; Van Gent, 2003).

Additions:

- ____________________
- ____________________
- ____________________

**8) CENTRES:**

**Skills:**

- Centres support both the wing and flyhalf by running straight (except when executing specific technical moves) and creating space (Van Gent, 2003).
- Make the most contact with opposing players (Quarrie *et al.,* 1996; Van Gent, 2003).
- They must be able to successfully pass the ball in contact situations (Van Gent, 2003).

- They fulfil offensive and defensive roles (Nicholas, 1997 in Van Gent, 2003).
- Centres are required to be good handlers of the ball and must be effective in passing the ball to the inside as well as outside under pressure (Rutherford, 1983; Van Gent, 2003).
- Aerial and ground kicks are important as are running skills such as side-steps and swerves (Van Gent, 2003).
- Must possess running, kicking, tackling and tackling skills (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ____________________
- ____________________
- ____________________

**Physical Motor:**

- Agility and speed are needed (Craven, 1974).
- Must create space for wings through rapid acceleration (Van Gent, 2003).
- Must be defensively sound (Joubert & Groenewald, 1998; Van Gent, 2003).
- They absorb substantial physical contact in offensive and defensive passages of play and they need intermittent speed with varies power, intensity and strength to attack the opposition (Nicholas, 1997 in Van Gent, 2003).
- Powerful legs and dynamic upper body strength are needed for driving force (Hare, 1997 in Van Gent, 2003).
- They require speed endurance (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ____________________
- ____________________
- ____________________

**Psychological Factors and Vision/Anticipation/Reading of Game:**

- ________________
- ________________
- ________________

**9) WINGS:**

**Skills:**

- Wings are involved in counter attack support, covering of the fullback when on attack as well as cross-defence (Pool, 1997; Van Gent, 2003).
- Wings chase high balls kicked onto the opposition, they apply pressure to the opposition wings and fullback, and are involved in defending against the opposition (Rutherford, 1983; De Ridder, 1993 in Van Gent, 2003).
- Must possess kicking, handling, catching, running and tackling skills (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ___________________
- ___________________
- ___________________

**Physical Motor:**

- An important requirement in wings is speed (Craven, 1974; Van Gent, 2003).
- Wings must beat the opposition through a combination of strength, agility and speed (Quarrie *et al.,* 1996; Van Gent, 2003).
- Need to be quick on cross-defence and fast (Joubert & Groenewald, 1998; Van Gent, 2003).
- Need speed and speed endurance (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ___________________
- ___________________
- ___________________

**Psychological Factors and Vision/Anticipation/Reading of Game:**

- ___________________
- ___________________
- ___________________

**10) FULL-BACKS:**

**Skills:**

- Acts as a second fly-half and needs to have good kicking and handling skills (Craven, 1974; Van Gent, 2003).
- Must be able to properly kick technical kicks on attack and be able to kick high balls to place pressure on the opposition (Van Gent, 2003).
- Must have pace to join the back-line movements during attacking moves (Van Gent, 2003) and must know where and when to enter the backline (Rutherford, 1983).
- Must be defensively sound (De Ridder, 1993 in Van Gent, 2003).
- Must posses running, handling, catching of high ball and tackling skills (Van der Merwe, 1989 in Van Gent, 2003).
- Must be able to read the game, kick with both feet, and have the speed to join the game attack and must be solid under the high ball (Pool, 1997; Van Gent, 2003).

Additions:

- ___________________
- ___________________
- ___________________

**Physical Motor:**

- Must possess agility and speed (De Ridder, 1993 in Van Gent, 2003).
- Must be able to outdo the opposition with strength and speed (Van Gent, 2003).
- Must have good overall endurance as well as speed endurance (Van der Merwe, 1989 in Van Gent, 2003).

Additions:

- ____________________
- ____________________
- ____________________

**Psychological Factors and Vision/Anticipation/Reading of Game:**

- ____________________
- ____________________
- ____________________

# APPENDIX C

# TESTING PROTOCOL SHEET

## SUBJECT DETAILS

| | |
|---|---|
| **Name and Surname** | ______________________________ |
| **Age** | _______ |
| **Position** | ________________ |
| **Injury?** | ______________________________ |

**NOTE-TESTS TO BE FOLLOWED STRICTLY IN ORDER**

## ANTHROPOMETRICAL COMPONENTS

| | |
|---|---|
| **1) Height (Body Stature)** | **______cm** |
| **2) Body Mass** | **______kg** |
| **3) Biceps SF*** | **______mm** |
| **4) Triceps SF*** | **______mm** |
| **5) Subscapular SF*** | **______mm** |
| **6) Suprailiac SF*** | **______mm** |

*Needed for Durnin & Wormersly

# PHYSICAL MOTOR

**1) Vertical Jump**

| | |
|---|---|
| Reach 1:_____cm | Jump 1:_____cm |
| Reach 2:_____cm | Jump 2:_____cm |
| Reach 3:_____cm | Jump 3:_____cm |

**2) 10m/40m Dash**

| | |
|---|---|
| 1:_____sec (10m) | 1:_____sec (40m) |
| 2:_____sec (10m) | 2:_____sec (40m) |

**3) T-test**

| | |
|---|---|
| 1:_____sec | 2:_____sec |

**4) 3x5x22m Aerobic Capacity Test**

| | |
|---|---|
| 5x22m Set 1 | _____sec |
| Rest (tick) | _____30 sec |
| 5x22m Set 2 | _____sec |
| Rest (tick) | _____30 sec |
| 5x22m Set 3 | _____sec |

## RUGBY SPECIFIC SKILLS

**1) S-Test 1) ___pts T:___sec 2) ___pts T:___sec**
**5 points per target hit**

**2) Kick for Distance & Accuracy**

**L: 1:___ ___m 2:___ ___m**

**R: 1:___ ___m 2:___ ___m**

## SPORT VISION TESTING

**Accuvision 1000-Test**

**1) 30 Accurate Lights Test in Total Time Test**

**1: Sec______**
**2: Sec______**

# APPENDIX D

## Descriptive Statistics per Group per Variable

## Non-Parametric Tests to determine whether statistically significant differences existed between the scores of the three positions on all variables measured.

## Kruskal-Wallis Test – Anthropometrical Components

**Ranks**

| | Grouped Positions | N | Mean Rank |
|---|---|---|---|
| Height (cm) | Tight Forwards | 21 | 49.24 |
| | Loose Forwards | 27 | 44.37 |
| | Backs | 30 | 28.30 |
| | Total | 78 | |
| Body Mass (kg) | Tight Forwards | 21 | 58.62 |
| | Loose Forwards | 27 | 41.33 |
| | Backs | 30 | 24.47 |
| | Total | 78 | |
| Biceps SF* (mm) | Tight Forwards | 21 | 48.74 |
| | Loose Forwards | 27 | 36.06 |
| | Backs | 30 | 36.13 |
| | Total | 78 | |
| Triceps SF* (mm) | Tight Forwards | 21 | 46.81 |
| | Loose Forwards | 27 | 35.59 |
| | Backs | 30 | 37.90 |
| | Total | 78 | |
| Suprailiac SF* (mm) | Tight Forwards | 21 | 49.05 |
| | Loose Forwards | 27 | 34.63 |
| | Backs | 30 | 37.20 |
| | Total | 78 | |
| Subscapular SF* (mm) | Tight Forwards | 21 | 51.90 |
| | Loose Forwards | 26 | 34.17 |
| | Backs | 30 | 34.15 |
| | Total | 77 | |
| Skintotal | Tight Forwards | 21 | 49.64 |
| | Loose Forwards | 26 | 33.79 |
| | Backs | 30 | 36.07 |
| | Total | 77 | |
| Body Fat % vs Skinfold thickness | Tight Forwards | 21 | 49.69 |
| | Loose Forwards | 26 | 33.31 |
| | Backs | 30 | 36.45 |
| | Total | 77 | |

**Test Statistics(a,b)**

| | Height (cm) | Body Mass (kg) | Biceps SF* (mm) | Triceps SF* (mm) | Suprailiac SF* (mm) | Subscapular SF* (mm) | skintotal | Body Fat % vs Skinfold thickness |
|---|---|---|---|---|---|---|---|---|
| Chi-Square | 12.486 | 28.335 | 4.789 | 3.139 | 5.287 | 9.615 | 6.680 | 6.879 |
| Df | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Asymp. Sig. | .002 | .000 | .091 | .208 | .071 | .008 | .035 | .032 |

a Kruskal Wallis Test
b Grouping Variable: Grouped Positions

## Kruskal-Wallis Test – Physical Motor Skills

**Ranks**

| | Grouped Positions | N | Mean Rank |
|---|---|---|---|
| Vertical Jump Difference between Reach distance and Best attempt on Vertical jump | Tight Forwards | 17 | 38.76 |
| | Loose Forwards | 24 | 36.46 |
| | Backs | 30 | 34.07 |
| | Total | 71 | |

**Test Statistics(a,b)**

| | Vertical jump (cm) best effort |
|---|---|
| Chi-Square | .583 |
| Df | 2 |
| Asymp. Sig. | .747 |

a Kruskal Wallis Test
b Grouping Variable: Grouped Positions

## Kruskal-Wallis Test

**Ranks**

| | Grouped Positions | N | Mean Rank |
|---|---|---|---|
| 10m Dash sec (10m) (1) (sec) | Tight Forwards | 18 | 42.94 |
| | Loose Forwards | 24 | 30.71 |
| | Backs | 25 | 30.72 |
| | Total | 67 | |
| 10m Dash sec (10m) (2) (sec) | Tight Forwards | 14 | 32.79 |
| | Loose Forwards | 19 | 19.92 |
| | Backs | 16 | 24.22 |
| | Total | 49 | |
| 10m Dash sec (10m) Lowest Score (sec) | Tight Forwards | 16 | 41.41 |
| | Loose Forwards | 20 | 27.63 |
| | Backs | 25 | 27.04 |
| | Total | 61 | |
| 40m Dash sec (40m) (1) (sec) | Tight Forwards | 18 | 46.33 |
| | Loose Forwards | 25 | 31.64 |
| | Backs | 25 | 28.84 |
| | Total | 68 | |
| 40m Dash sec (40m) (2) (sec) | Tight Forwards | 13 | 33.54 |
| | Loose Forwards | 19 | 20.95 |
| | Backs | 16 | 21.38 |
| | Total | 48 | |
| 40m Dash sec (40m) lowest score (sec) | Tight Forwards | 18 | 49.58 |
| | Loose Forwards | 25 | 30.36 |
| | Backs | 25 | 27.78 |
| | Total | 68 | |

**Test Statistics(a,b)**

| | 10m Dash sec (10m) Lowest Score (sec) | 40m Dash sec (40m) (1) (sec) | 40m Dash sec (40m) (2) (sec) | 40m Dash sec (40m) lowest score (sec) |
|---|---|---|---|---|
| Chi-Square | 7.471 | 9.021 | 7.446 | 14.464 |
| df | 2 | 2 | 2 | 2 |
| Asymp. Sig. | .024 | .011 | .024 | .001 |

a Kruskal Wallis Test
b Grouping Variable: Grouped Positions

# Kruskal-Wallis Test

**Ranks**

| | Grouped Positions | N | Mean Rank |
|---|---|---|---|
| T-test (1) (sec) | Tight Forwards | 18 | 46.00 |
| | Loose Forwards | 25 | 30.44 |
| | Backs | 26 | 31.77 |
| | Total | 69 | |
| T-test (2) (sec) | Tight Forwards | 14 | 33.21 |
| | Loose Forwards | 19 | 22.03 |
| | Backs | 16 | 21.34 |
| | Total | 49 | |
| T-test lowest score | Tight Forwards | 18 | 46.81 |
| | Loose Forwards | 25 | 29.78 |
| | Backs | 26 | 31.85 |
| | Total | 69 | |
| Anaerobic Capacity 5x22m set 1 (sec) | Tight Forwards | 18 | 39.50 |
| | Loose Forwards | 25 | 29.38 |
| | Backs | 25 | 36.02 |
| | Total | 68 | |
| Anaerobic Capacity 5x22m set 2 (sec) | Tight Forwards | 18 | 46.61 |
| | Loose Forwards | 25 | 28.38 |
| | Backs | 25 | 31.90 |
| | Total | 68 | |
| Anaerobic Capacity 5x22m set 3 (sec) | Tight Forwards | 17 | 44.97 |
| | Loose Forwards | 22 | 26.80 |
| | Backs | 25 | 29.04 |
| | Total | 64 | |

**Test Statistics(a,b)**

| | T-test (1) (sec) | T-test (2) (sec) | T-test lowest score | Anaerobic Capacity 5x22m set 1 (sec) | Anaerobic Capacity 5x22m set 2 (sec) | Anaerobic Capacity 5x22m set 3 (sec) |
|---|---|---|---|---|---|---|
| Chi-Square | 7.378 | 6.498 | 8.570 | 2.988 | 9.614 | 10.585 |
| Df | 2 | 2 | 2 | 2 | 2 | 2 |
| Asymp. Sig. | .025 | .039 | .014 | .224 | .008 | .005 |

a Kruskal Wallis Test
b Grouping Variable: Grouped Positions

## Kruskal-Wallis Test – Vision Test

**Ranks**

| | Grouped Positions | N | Mean Rank |
|---|---|---|---|
| Accuvision 1000 Test (30 lights test) (sec) | Tight Forwards | 15 | 32.00 |
| | Loose Forwards | 18 | 21.56 |
| | Backs | 18 | 25.44 |
| | Total | 51 | |

**Test Statistics(a,b)**

| | Accuvision 1000 Test (30 lights test) (sec) |
|---|---|
| Chi-Square | 4.119 |
| df | 2 |
| Asymp. Sig. | .127 |

a Kruskal Wallis Test
b Grouping Variable: Grouped Positions

**APPENDIX E**

# Simulated data

## Descriptives for Tight-Forwards on Anthropometrical Components

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Height (cm) | 250 | 171.75 | 201.47 | 185.4830 | 6.95572 |
| Body Mass (kg) | 250 | 83.22 | 115.99 | 101.9518 | 7.74215 |
| Biceps SF* (mm) | 250 | 3.45 | 9.19 | 6.1838 | 1.38038 |
| Triceps SF* (mm) | 250 | 7.26 | 24.89 | 15.0627 | 4.37526 |
| Suprailiac SF* (mm) | 250 | 5.95 | 51.96 | 24.4743 | 10.63275 |
| Subscapular SF* (mm) | 250 | 7.70 | 27.17 | 16.6849 | 4.74259 |
| Skintotal | 250 | 27.65 | 103.44 | 61.4950 | 18.66609 |
| Body Fat % vs Skinfold thickness | 250 | 11.93 | 24.99 | 18.9538 | 3.28714 |
| Valid N (listwise) | 250 | | | | |

## Descriptives for Tight-Forwards on Physical-Motor Skills

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Vertical jump (cm) 1 | 250 | 220.68 | 317.54 | 267.6816 | 24.55104 |
| Vertical jump (cm) 2 | 250 | 216.83 | 319.97 | 266.2885 | 25.55117 |
| Vertical jump (cm) best effort | 250 | 220.60 | 319.54 | 269.3776 | 25.05146 |
| Vertical Jump Difference between Reach distance and best attempt | 250 | 41.01 | 63.93 | 53.2460 | 5.51651 |
| 10m Dash sec (10m) Lowest Score (sec) | 250 | 1.82 | 2.35 | 2.1264 | .12858 |
| 40m Dash sec (40m) lowest score (sec) | 250 | 5.33 | 6.56 | 5.9448 | .29372 |
| T-test lowest score | 250 | 10.46 | 13.33 | 11.6222 | .67761 |
| Anaerobic Capacity 5x22m set 1 (sec) | 250 | 20.51 | 23.21 | 21.9930 | .67193 |
| Anaerobic Capacity 5x22m set 2 (sec) | 250 | 21.16 | 27.05 | 23.9308 | 1.30961 |
| Anaerobic Capacity 5x22m set 3 (sec) | 250 | 21.84 | 27.35 | 24.5261 | 1.39397 |
| Accuvision 1000 Test (30 lights test) (sec) | 250 | 19 | 29 | 24.18 | 2.477 |
| Valid N (listwise) | 250 | | | | |

## Descriptives for Loose-Forwards on Anthropometrical Components

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Height (cm) | 250 | 170.39 | 193.72 | 182.4141 | 5.34549 |
| Body Mass (kg) | 250 | 71.79 | 106.49 | 92.1370 | 7.23231 |
| Biceps SF* (mm) | 250 | 3.13 | 9.16 | 5.4633 | 1.32353 |
| Triceps SF* (mm) | 250 | 5.10 | 18.88 | 11.0897 | 2.92889 |
| Suprailiac SF* (mm) | 250 | 6.77 | 35.74 | 15.9212 | 5.67021 |
| Subscapular SF* (mm) | 250 | 7.06 | 18.33 | 11.6752 | 2.37788 |
| Skintotal | 250 | 25.55 | 75.35 | 43.2199 | 10.10560 |
| Body Fat % vs Skinfold thickness | 250 | 11.04 | 24.49 | 16.3645 | 2.69821 |
| Valid N (listwise) | 250 | | | | |

## Descriptives for Loose-Forwards on Physical-Motor Skills

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Vertical jump (cm) 1 | 250 | 222.68 | 309.74 | 272.0851 | 20.93121 |
| Vertical jump (cm) 2 | 250 | 222.77 | 313.99 | 273.9266 | 21.99182 |
| Vertical jump (cm) best effort | 250 | 223.30 | 313.72 | 274.3501 | 21.86138 |
| Vertical Jump Difference between Reach distance and best attempt | 250 | 39.15 | 66.88 | 53.4937 | 6.08430 |
| 10m Dash sec (10m) Lowest Score (sec) | 250 | 1.69 | 2.43 | 2.0257 | .16773 |
| 40m Dash sec (40m) lowest score (sec) | 250 | 4.93 | 6.31 | 5.5938 | .30959 |
| T-test lowest score | 250 | 9.78 | 12.50 | 10.8147 | .60497 |
| Anaerobic Capacity 5x22m set 1 (sec) | 250 | 19.76 | 23.69 | 21.5763 | .88241 |
| Anaerobic Capacity 5x22m set 2 (sec) | 250 | 20.58 | 25.06 | 22.5631 | 1.02314 |
| Anaerobic Capacity 5x22m set 3 (sec) | 250 | 19.92 | 24.96 | 22.5174 | 1.13407 |
| Accuvision 1000 Test (30 lights test) (sec) | 250 | 18 | 28 | 22.37 | 2.474 |
| Valid N (listwise) | 250 | | | | |

## Descriptives for Backs on Anthropometrical Components

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Height (cm) | 250 | 171.08 | 192.26 | 179.2819 | 4.89787 |
| Body Mass (kg) | 250 | 64.81 | 111.97 | 86.0929 | 9.24403 |
| Biceps SF* (mm) | 250 | 3.42 | 10.68 | 5.7281 | 1.41499 |
| Triceps SF* (mm) | 250 | 5.48 | 18.66 | 11.4469 | 2.99176 |
| Suprailiac SF* (mm) | 250 | 5.50 | 36.55 | 17.1261 | 6.73050 |
| Subscapular SF* (mm) | 250 | 5.89 | 20.72 | 11.6209 | 2.90216 |
| Skintotal | 250 | 23.70 | 84.45 | 46.0682 | 12.78660 |
| Body Fat % vs Skinfold thickness | 250 | 10.11 | 24.96 | 16.8523 | 3.33480 |
| Valid N (listwise) | 250 | | | | |

## Descriptives for Backs on Physical-Motor Skills

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Vertical jump (cm) 1 | 250 | 201.43 | 298.73 | 255.9915 | 24.10423 |
| Vertical jump (cm) 2 | 250 | 205.53 | 299.99 | 259.0357 | 23.44387 |
| Vertical jump (cm) best effort | 250 | 205.03 | 299.74 | 258.2484 | 23.71965 |
| Vertical Jump Difference between Reach distance and best attempt | 250 | 41.10 | 64.50 | 52.6260 | 4.91956 |
| 10m Dash sec (10m) Lowest Score (sec) | 250 | 1.75 | 2.39 | 2.0247 | .14414 |
| 40m Dash sec (40m) lowest score (sec) | 250 | 5.04 | 6.33 | 5.5749 | .28014 |
| T-test lowest score | 250 | 9.23 | 12.83 | 10.8152 | .79879 |
| Anaerobic Capacity 5x22m set 1 (sec) | 250 | 19.11 | 23.69 | 21.6320 | 1.05829 |
| Anaerobic Capacity 5x22m set 2 (sec) | 250 | 19.96 | 27.51 | 22.9971 | 1.52713 |
| Anaerobic Capacity 5x22m set 3 (sec) | 250 | 20.76 | 26.83 | 23.0414 | 1.24683 |
| Accuvision 1000 Test (30 lights test) (sec) | 250 | 17 | 29 | 22.89 | 3.054 |
| Valid N (listwise) | 250 | | | | |