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.

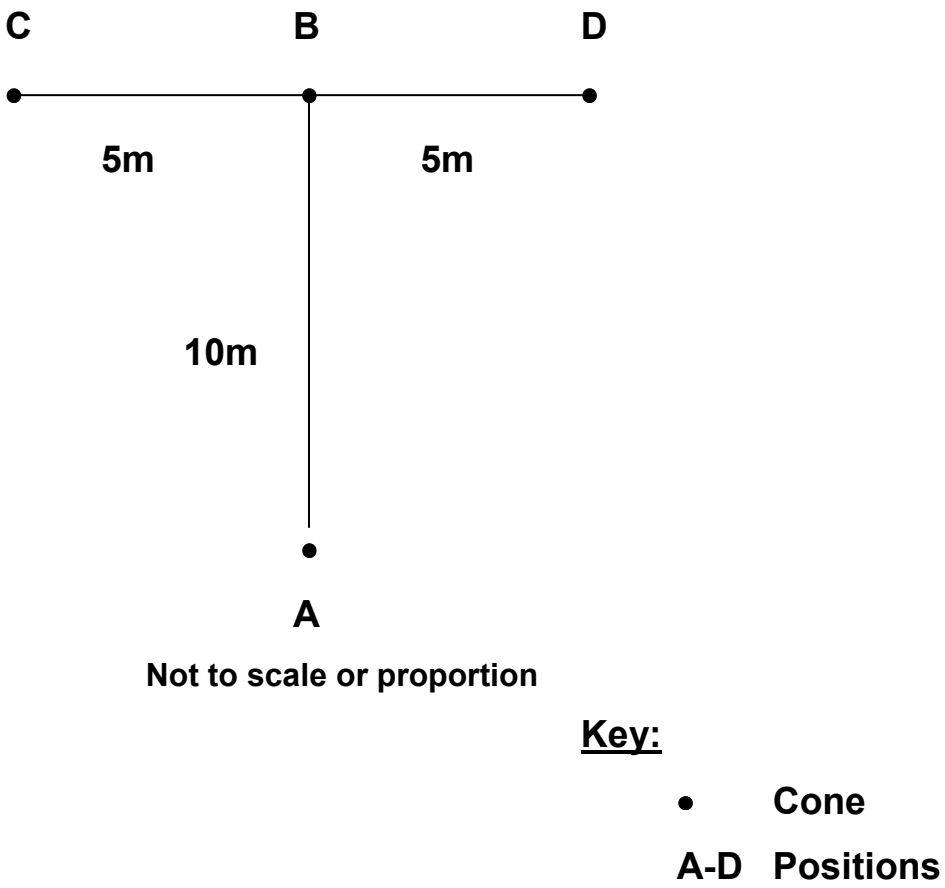

Figure 7.1: Illustration of the T-Test for agility (Adapted from Harman *et al.,* 2000:298)

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.

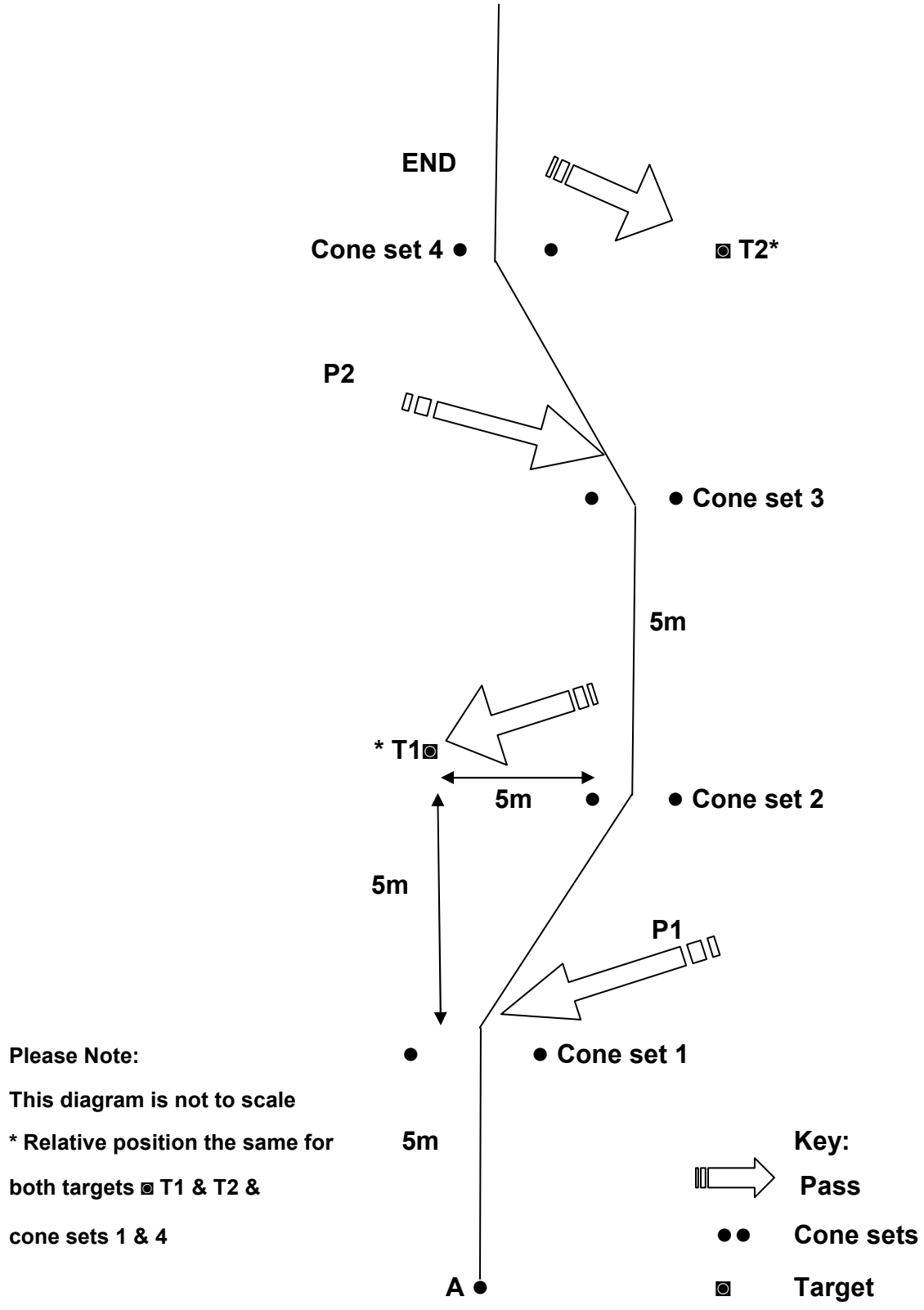

Figure 7.2: Illustration of the S-Test for passing accuracy

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.

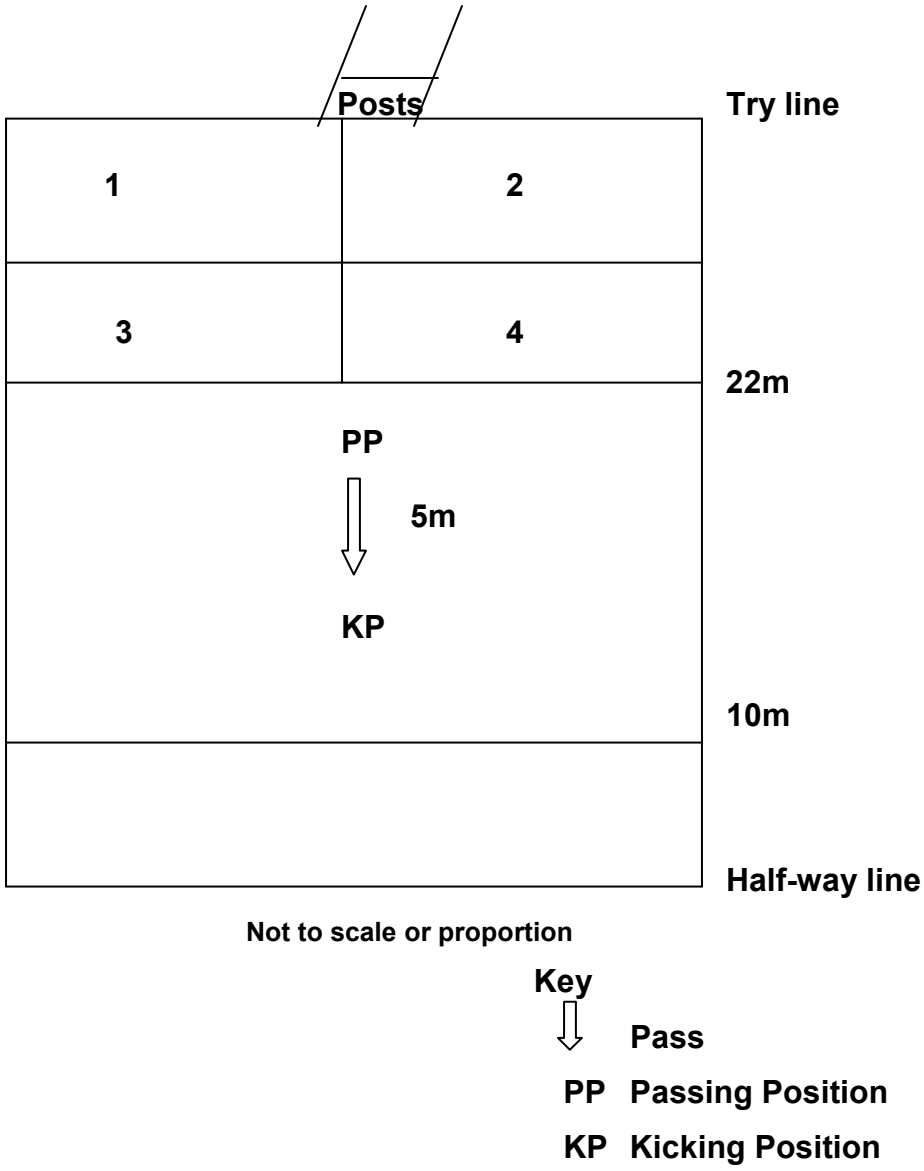

Figure 7.3: Illustration of the kick for accuracy (quadrant) test

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.

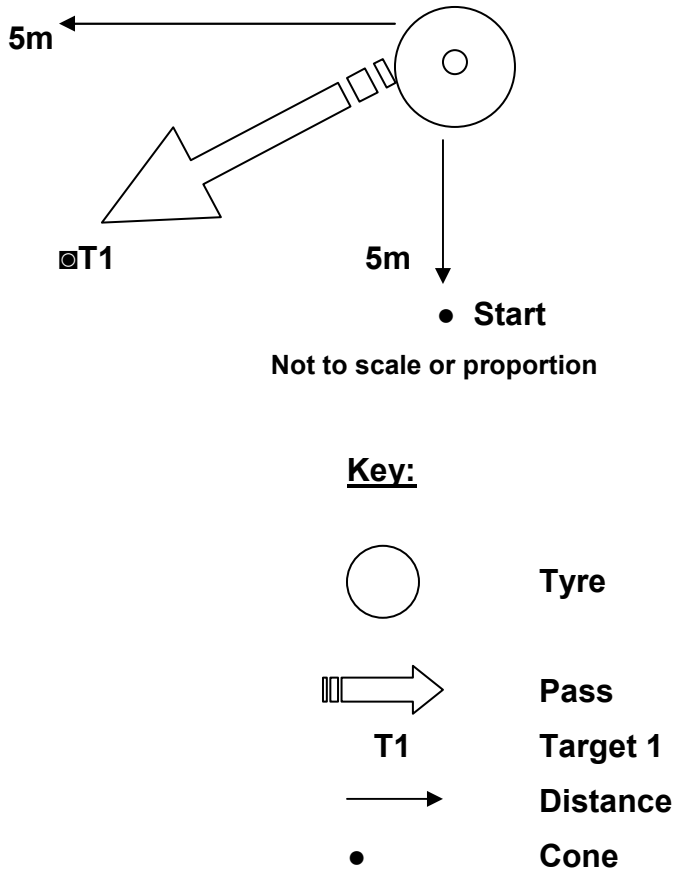

Figure 7.4: Illustration of the scrumhalf tyre pass test

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.