# 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.

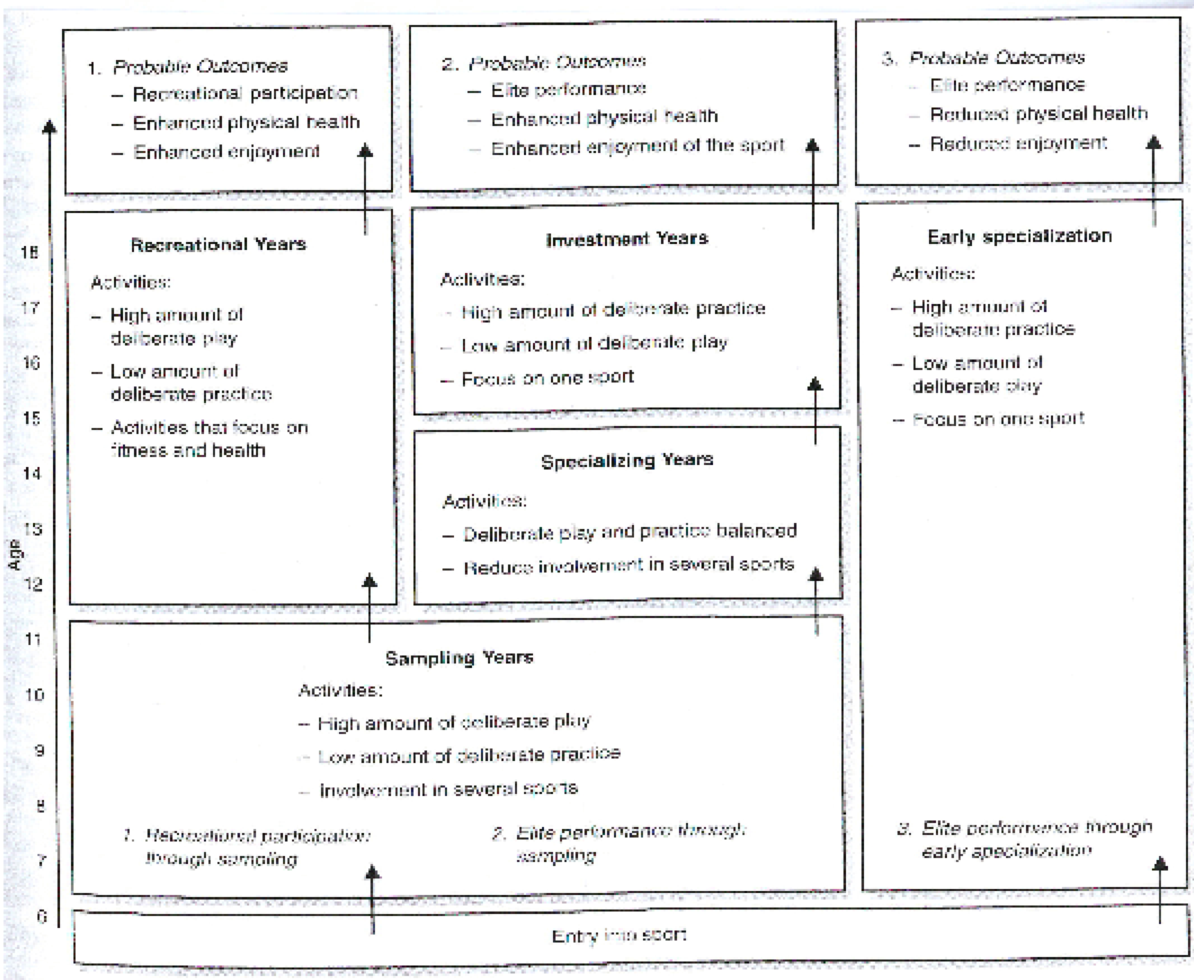


**Figure 4.1: Developmental Model of Sport Participation (Côté *et al.,* 2007:197)**

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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.