Hogeschool van Arnhem en Nijmegen
HAN University of Applied Sciences

RESEARCH GROUP | FOR TALENT IDENTIFICATION AND DEVELOPMENT IN SPORTS

Sustainable investment in sports talent

The path to the podium through the school and the sports club

Lector dr. Johan Pion

HAN

RESEARCH

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Research Group for Talent Identification and Development in Sports
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Introduction

Wouldn't it be wonderful if all children were able to exploit their talents to the fullest? It was based on this dream that the Research Group for Talent Identification and Development in Sports was launched at HAN University of Applied Sciences in 2012. HAN lecturers, students and staff have begun to examine sports talent in children through various projects in schools and clubs. In 2016, a decision was made to transform the dream into reality and to investigate in practice how we can make sustainable investments in sports talent. Helping children choose the right sport can be better facilitated. The future enhancement of this selection process will now be charted in methodical and structural terms.

Knowledge and understanding about the identification and development of talent are important to increasing the performance level of Dutch sports in general, and particularly with regard to talented athletes and elite athletes in the region. This is the most important underlying idea and justification for the Research Group for Talent Identification and Development in Sports. Within the domain of sports and exercise sciences, the research group focuses on ALL CHILDREN, with particular attention to children with exceptional motor talent. The latter are characterised by their current superior performance in comparison to their age peers and their potential to continue such performance in the future. Top performance does not occur by chance. It is preceded by a long and complex process. Understanding this process of 'bringing out the best in oneself' could help to improve the guidance provided to children with exceptional talent on their way to 'the top'.

1

Talent Identification and Development in Sports

The primary goal of the Research Group for Talent Identification and Development in Sports is to work within the domain of sports and exercise sciences to generate greater knowledge and understanding about the processes of identifying and developing sports talent. A secondary goal is to translate the knowledge obtained within the research group to ordinary children and the youth, as well as to other contexts and target groups, including our own HAN students and staff members. One perceived accompanying benefit is that the knowledge and experience generated by the research group could be used in the commercial sector, within the context of labour and rehabilitation. This is conceivable, given that most of the principles underlying the process of 'bringing out the best in oneself' transcend single disciplines.

The international trend in talent identification and development is subject to the pressure for short-term performance. Competition is fierce and investments primarily go to the athletes who have already more or less proven that they have the potential to score at the highest level. The sole focus appears to be medals. Programmes to improve the performance of elite athletes are tailored to the four-year cycle of the Olympic Games (Laing 2014, Kinugasa 2014). Efforts to improve what is already good now are considered in terms of four (4) and eight (8) years prior to the podium. As a result, the competing countries look to each other, adopting the strongest ideas and programmes from each other. Although this might pay off in the short term, at some point, it will take more to become the best. Long-term thinking requires an approach that can treat every child's talent with care. To limit talent loss, each talent should be detected early. Broad development can subsequently ensure that all options remain open for specialisation at the proper time.

1.1. Concepts

Below is an overview of common terminology used in this regard with short descriptions of the concepts.

'Talent' indicates that an individual has an advantage over his or her age peers. Although there is no single definition of talent, it can be regarded as a basis for predicting domain-specific performance. Talent is partly hereditary and occurs only in a limited number of people within a given population (Howe, 1998). Skills and techniques demonstrated at a young age should not automatically be regarded as conditions for talent development and performance. Talent depends on a combination of hereditary and environmental factors. Talent is difficult to identify and may be lost because it was never noticed. Practice and encouragement are important conditions for exceptional performance. Children practise more when they enjoy the sport and are making progress.

Talent characteristics indicate that athletes are able to draw upon natural abilities that ensure they are amongst the best in their age group within a particular discipline. As noted by Müller et al. (2000), the development of talent towards elite sport requires knowledge of the specific talent characteristics of the sport. Tests are selected for each of the hypothetically relevant talent characteristics, based on publications, expert opinions and match analyses. The correlation between the results for talent characteristics and those for performance level validates the test battery and generates a sport-specific test battery and norms.

Talent detection involves finding giftedness in sports within a heterogeneous population (in this case, a group of young people who have not yet chosen a specific sport). It is the search for new athletes with potential in specific sports disciplines (Williams and Reilly, 2000). For example: In a non-organised game on a playground, a child can be identified as a talented basketball player.

Talent orientation can motivate someone to choose a sport based on their sport-specific talent characteristics. Some sports require early talent orientation, given the very young age of athletes at the highest level (Papic, 2009).

Talent identification is the process by which the most talented individuals are found within a specific domain in a homogeneous population. Athletes who might be capable of top performances are identified within specific sports disciplines (Williams and Reilly, 2000). For example: A young basketball player could be identified during a basketball game.

Talent development is offering optimal opportunities for development and training to talented athletes in order to perfect their talents. Talent development focuses on the training process for potential elite athletes in order to allow them to achieve their maximum performance levels in specific sports (Williams and Reilly, 2000).

Talent selection involves selecting the athletes who are best suited to specific tasks at specific times. This process takes into account all factors that could play a role for this task (e.g. line-up) (Williams and Reilly, 2000). Some authors refer to natural selection and scientific selection. Natural selection refers to selection throughout the athletic development process, with the better athletes at some point having the chance to grow based on their performance. Scientific selection focuses on potential established through measurements performed by experts (Bompa and Haff, 2009).

Talent transfer allows excellent athletes who are not at the absolute top in a particular sport to break through in another sport discipline. For example UK Sport's 'Sporting Giants' campaign is aimed at screening adult athletes according to their likelihood of winning a medal by transferring from one sport to another (Vaeyens et al., 2009).

1.2. Talent models (theory)

In the past five decades, several research groups have adopted their own interpretations of the concept of talent and the manner in which it develops. This has produced a wide array of models for framing the concept. Despite a preponderance of popular, frequently cited concepts and frameworks within the contemporary literature, many gaps remain with regard to problems that professional athletes experience in practice and how they could be assisted with regard to these problems (Bergeron et al., 2015; Gulbin & Weissensteiner, 2013). The following is an attempt to group some of these models according to their main objective.

Predicting performance

In the 1970s, sports scientists introduced several models to investigate the relationship between various predictors (e.g. anthropometric, physical and psychological variables) and performance (Wolkow, 1974; Bar-Or, 1975; Jones & Watson, 1977 and Geron, 1978). The multi-factorial approach was combined with a longitudinal follow-up of talent characteristics and multivariate statistical techniques (regression analysis) for detecting talent in sports (heterogeneous population: e.g. children playing different sports at school) and identifying talent in sport (homogeneous population: e.g. children in a club, all of whom play the same sport). In addition to anthropometric, physical and motor performance characteristics, these scholars also examined psychological differences between elite and sub-elite athletes. Gabler and Ruoff (1979) laid the foundation for the 'Sliding Population Approach' developed by Régnier et al. in 1993. This approach is an important milestone in talent research. The basic idea underlying this model is that different factors are measured at different ages because they become relatively more important in the athlete's development.

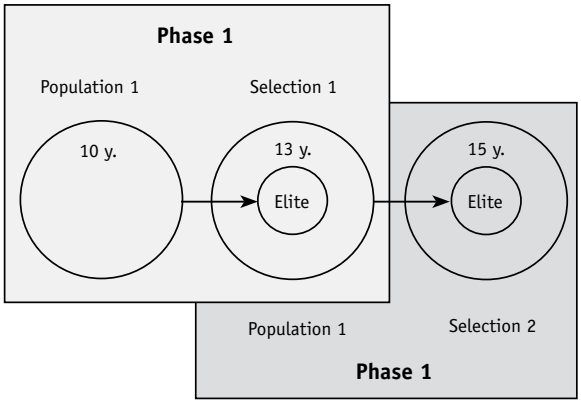

Figure 1: The sliding population approach (adapted by Régnier et al., 1993)

This model from 1993 stresses the importance of the tests at various ages. This can be illustrated by the impact of endurance or strength on performance, which varies before and after the growth spurt. This model has been translated to practice by various scholars, including Balyi and Hamilton (2004). The Long-Term Athlete Development (LTAD) model relies on a physiological framework in which the sensitive developmental stages in biological development are described as 'windows of opportunity'. Empirical evidence for the model is lacking and interpretations of the model are often based on questionable assumptions and inappropriate methods. For practitioners, it is important to note that the LTAD model is regarded as a controversial practical model, which is in need of further optimisation by researchers in order to be considered valid and reliable (Ford et al., 2011; Tucker, 2014).

Developing from gifted to talented

Development models examine the transition from giftedness to talent. As early as the 1970s, Geron (1978) made a distinction between raw and systematically developed skills. Gagné (2004) later applied this distinction in the 'Differentiated Model of Giftedness and Talent' (DMGT). Studies by Bloom (1985) and by Csikszentmihalyi et al. (1993) proceed from the assumption that talent must undergo development within an optimal environment. Both of these studies examined talent in a variety of sectors (i.e. art, sports, music, mathematics and sciences). Gagné (2004) makes a clear distinction between giftedness and talent. The DMGT describes how natural gifts are developed into ultimate talent. Such development is influenced by various catalysts:

1) Intra-personal catalysts (e.g. physical characteristics, motivation, willpower, self-management and personality);
2) Environmental factors (e.g. friends and workmates, social class, economic and geographical factors and the way in which the environment is structured to simplify progress in training);
3) Random factors or conditions (Figure 2).

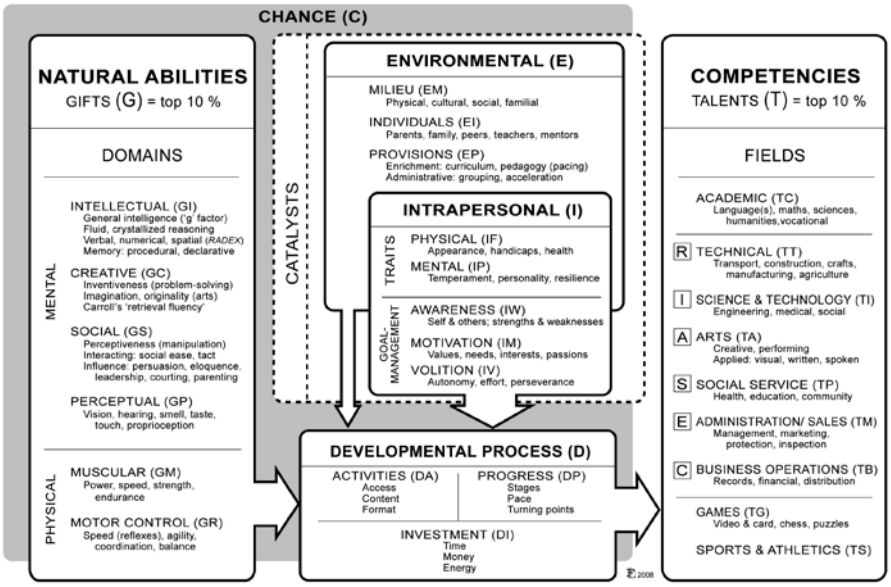

Figure 2: The Differentiated Model of Giftedness and Talent (Gagné, 2004)

Parallel to the DMGT, a similar model – Münchener Hochbegabungsmodell – was developed by Heller (2004), also based on talent characteristics (predictors), environmental factors and personality traits (moderators), resulting in performance areas.
During the first period of the research group, Marije Elferink-Gemser developed a model indicating how athletes continually have to improve their sports performance on their way to the top (Elferink-Gemser and Visscher, 2012). Although no development is linear, it is important to note that performance levels increase over time. The model illustrates the applicability of this tendency in terms of motor skills, as well as at the cognitive, emotional and social level. A young child attending primary school will eventually become an adolescent, a teenager and, finally, an adult. A great deal happens during this period, including major advances in sports performance. Although these advances are due largely to personal qualities that determine performance, the effect of coincidence or chance should not be underestimated. The qualities that determine performance qualities can be divided into physique (e.g. height, weight, body fat percentage), physiological qualities (e.g. aerobic and anaerobic energy systems), technique (sport-specific skills, as with dribbling, passing and shooting in football), tactics

(cognitive qualities, including taking the right decision at the right time) and mental qualities (e.g. performing under pressure). The qualities that determine performance are derived from the characteristics of the sport performance. These qualities contribute to performance level in a different way for each sport. In addition, environmental factors and the athlete's personality have an influence on whether these qualities will be developed.

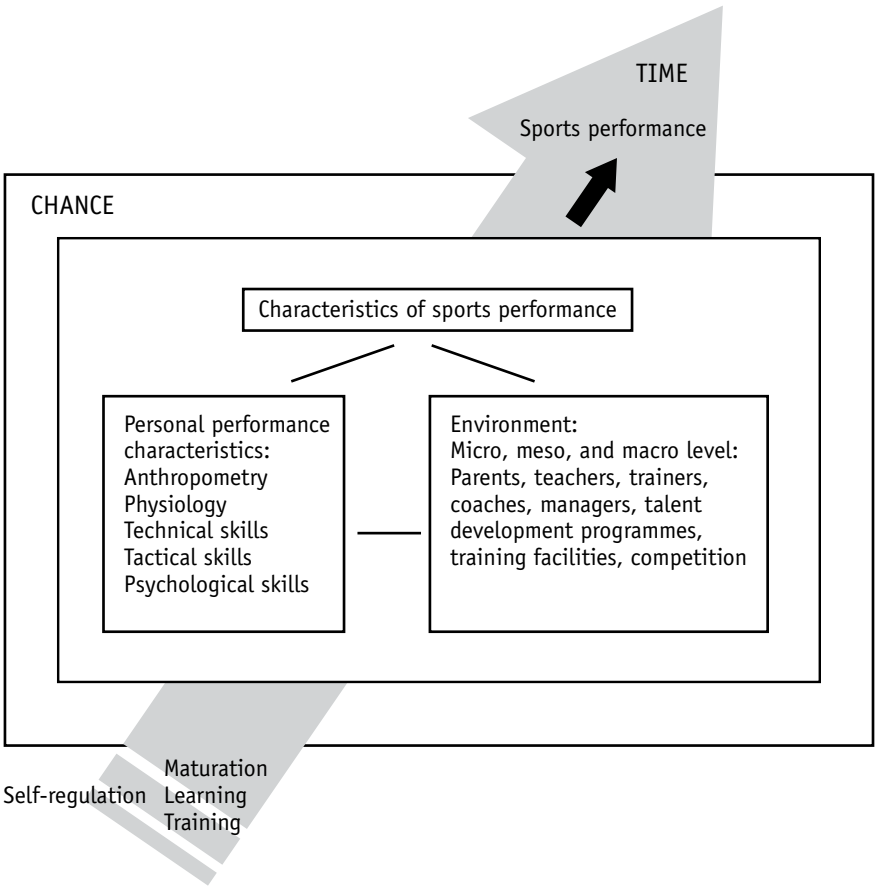

Figure 3: Model of talent identification and talent development in sports (Elferink-Gemser and Visscher, 2012)

Influence of heredity and development

The manner in which performance develops depends in part on genetic and developmental factors. The literature on sports genetics supports both the influence of the innate giftedness of those with superior motor skills and the influence of environmental factors for developing in the sport. The relative contribution of genes (nature) and development (nurture) to performance, however, remains unclear. In addition, these contributes are likely to differ per sport. It could therefore be assumed that, in some sports, genetic factors are more important than development factors (Tucker and Collins, 2012).

Howe et al. (1998) assume that talent can be recognised at a young age and that development, motivation and confidence lead to top performance. Other authors (e.g. Rose, 1995) do not share this proposition, given that talent is hereditary and does not necessarily determine an athlete's fate. Johnson and Tenenbaum (2006) see a direct link between genetic talent and sports performance. 'Nature' refers to the innate ability to excel in a sport, while high-quality training is absolutely necessary to develop skills (Davids and Baker, 2007). It assumed that the ACE and ACTN3 genes are able to affect physical performance. The initial estimates assumed that 90% of aerobic stamina is genetically determined (Klisouras, 1971). New insights show that genetics play a smaller role in determining endurance (Hopkins and Hewson 2001). For certain traits, genetics have proven less important than originally thought. Bouchard et al. (1997) subscribe to the view that, in addition to the importance of the various traits, trainability might even be the most important innate factor.

Deliberate practice and deliberate play

Engaging in focused play, training and programmes are indispensable components of development in sports. Harre (1982) argues that talent is trainable. This claim is further emphasised by Ericsson et al. (1993) in their hotly contested '**deliberate practice**' rule of 10,000 hours. Proponents have since aligned themselves with the notion of '**deliberate play**' and the importance of play as an integral part of training (Coté & Fraser-Thomas, 2007). Bullock's (2009) '**deliberate programming**' experiment was a step towards a rapid transition from giftedness to talent. Although the final result is determined by play, training and the way context and culture effect development, there are several paths to sporting success (Suppiah et al., 2015). Choosing the wrong sport can have adverse effects on pleasure, which can be difficult to compensate through

training. What children like doing and are good at doing is extremely important in being able to offer a '**deliberate choice**' (Pion, 2015d).

1.3. Talent systems (practice)

Two talent systems serve as models for the new elite sports systems in several countries: on the one hand the system used in the GDR during the 1970s and 1980s and on the other the large-scale impulses of the Australian Institute of Sport (AIS) in its build-up to the 2000 Olympic Games. The AIS built upon the expertise of the GDR, thereby demonstrating the possibility of learning and building upon the practices of other countries. These two systems are the starting point of the 'global sporting arms race'. The talent detection, talent identification and talent development practices of the former Eastern Bloc, Cuba and the former Soviet Union, in which talented children were identified at a young age and then trained to become champions, drew considerable criticism from around the world. On the other hand, the early detection of potential in order to provide all children with every possible opportunity could be a way of helping them to get to know their talents and make better choices. Complete rejection of the Eastern Bloc system would be hasty, as you can also learn from mistakes. The talent identification programmes in Eastern Europe were centrally managed and efficient, given the large population that was reached. The system was based on a sports culture in which physical and anthropometric variables were used to conduct the selections. Sport was regarded as a weapon and winning was a necessity. The manner in which potential champions were trained with the GDR State Plan 14.25 (Hungermann, 2006) was responsible for the negative connotations associated with the policy-driven, structured practice of identifying and developing talent in sports. The state-initiated GDR system subordinated the individual to the 'national interest'. The organisation and structure of the GDR programme were trend-setting. Combined with the early detection of talented athletes in clubs, the compulsory detection programme in schools led to an exceptional influx of talented athletes in a variety of sports disciplines. Supporting talent development and searching for specific sports disciplines with more chances of scoring were very expensive strategies that were later adopted by several countries as a means of achieving success in international competitions.

In addition to the former Eastern Bloc countries, other countries also repeatedly score well in the medal tally at the Olympic Games. They have well-developed talent programmes that can serve as examples for Western European countries. In Australia,

talent was recruited online until 2009 amongst aspiring elite athletes between the ages of 12 and 25 years registering through the 'eTID' talent identification protocol on the website of the Australian Sports Commission. The online programme was an extension of the National Talent Identification and Development Program, initiated in 1980. The emphasis was on athletics, cycling, canoeing, rowing, triathlon and beach volleyball. The protocol allowed participants to conduct a few basic tests at home and to forward the results through the website, which were then processed centrally. The better participants were then invited for a follow-up in a national centre. The talent-detection programme was eventually discontinued due to the vastness of the country and the high cost.

An extreme example of an expensive strategy is 'Project 119'. During the 2008 Olympic Games, the Chinese government supported athletes in sports that traditionally had yielded fewer medals. The Chinese government had made an unlimited budget available to earn medals in athletics, canoeing and kayaking, rowing, sailing and swimming. Launched in 2002, the programme's name referred to the number of medals that China wanted to earn during the 2008 Olympic Games in its own country (Jones, 2008).

In the United Kingdom, a large-scale programme was launched in 2002. UK Sport is an organisation positioned between athletes/sports federations and policy. Its core tasks are to follow athletes, to evaluate and adjust systems and structures of sports federations and, especially, to improve the climate for elite sports. It is currently the most advanced system for talent searching and consists of five themes that build on each other: Talent Identification, Talent Selection, Talent Transfer, Talent Confirmation and World Class Development (Laing 2014).

When a country gets to host the Olympic Games, this is often accompanied by renewed efforts for success in the home country. In Australia (2000), China (2008) and the United Kingdom (2012), a large amount of money was made available for performance in the home country. The Japanese model is now adding a new dimension to the existing systems. Actions aimed at short-term performance are being combined with long-term projects. The Japanese system of detection-identification-transfer includes three systems that have been adopted for 700 athletes in 12 regional centres. In an initial series of elite sports centres, efforts are being made in the area of classic talent development, with screenings and selections in specific sports. In addition, Talent Transfer Centres retrain outstanding athletes in new sports that are suited to their qualities.

Finally, the new Multi-Sport Centres bring clusters of sports together to develop athletes broadly before allowing them to specialise in the other centres. Japan has three types of sports academies. 1) Classic elite sports academies that focus on one sport 2) Junior elite sports academies that provide broad basic training. These sports academies develop young athletes in related sports based on clustered talent characteristics. 3) Talent transfer schools, where junior elite athletes are retrained to other sports in which they can achieve more success.

It is difficult for small countries to be guided by the examples from the GDR, Australia, China, the United Kingdom and Japan, given the large population for recruiting athletes and the large budgets spent on recognising and developing talent in these countries. Nevertheless, this does not prevent them from adopting knowledge to remain competitive. The driving force must come primarily from the original approach, in which weaknesses are converted into strengths. To quote the famous Dutch football player, Johan Cruijff, 'Every disadvantage has its advantage'. Small countries with the disadvantage of a small pool of talent have the advantage that the small size of the pool makes it easier to recognise and develop each child's talent. Small countries need for a large-scale system that will allow them to compete against the systems of large countries. What would be costly and too extensive in large countries could offer opportunities in smaller countries, where it is easier to maintain an overview.

1.4. Methods of predicting talent

In the past, it has been demonstrated that talent detection in large countries comes at a high cost. It is also reasonable to question whether the instinctive identification of talent is sufficient to ensure the sustainable management of the potential within the group. At present, too few actions are being taken to limit the loss of talented athletes. The 'eye of the master' (i.e. the trainer's judgement), the age-dependent test battery and advanced statistical methods are indispensable to reducing the costs of talent detection. Interested parties may share the data, thereby taking talent identification a step further. This is because the data collected do not contain only sport-specific information. They also reaffirm the generic results registered in former assessments.

Talent identification is usually synonymous with selection, but the disadvantage of selection is that a number of athletes will not be selected. Research in tennis has shown that physical fitness tests are not very capable of identifying differences between who

will and will not be successful (Kramer et al., 2016). The identification process can be carried out more accurately when the selection is based on the trainer's knowledge, the age-dependent test battery and statistical methods. A study on talent identification in gymnastics examined whether the trainer's judgement is as accurate as the information that could be extracted from a sport-specific test battery (Vandorpe et al., 2012a). According to the results, only the KTK (i.e. the KörperkoordinationsTest für Kinder; Kiphard & Shilling, 2007) was able to accentuate the differences at the top. The trainer's judgement and the anthropometric and physical tests were less discriminating and were more likely to reflect current performance levels than the potential to develop (Vandorpe et al., 2012b). The value of the KTK was again demonstrated in the field of volleyball, where it was able to predict which elite athletes would ascend the podium at the 2013 European Championship, five years after the baseline measurement (Pion et al., 2015a). The use of valid tests increases the chance of successfully identifying talent by 20% (Vandorpe et al., 2012b). The strongest predictions are based on a combination of the trainer's judgement, a sport-specific test battery and valid predictive models. This combination increases the likelihood of making a good selection by 15%. Additional savings could be realised by limiting the number of false positives and false negatives in selecting candidates (Pion et al., 2017).

Talent development primarily involves 'the survival of the fittest'. Who will be eliminated and who will remain? In a gymnastics study, results from a Kaplan-Meier analysis demonstrated that, five years after the entrance test for seven-year-old girls, only 18% of the original group remained in competition. The Cox Proportional Hazards instrument was also able to indicate which performance characteristics could be predicted. It concerns nine basic movements (129%), shoulder strength (96%), speed (68%) and the KTK (45-73%). More specifically, for example, a seven-year-old girl with a time of 3,902 seconds on the 20 m sprint would be 68% more likely to enter the highest level of gymnastics at the age of 12 than her friend who runs at a speed of 4,762 seconds (Pion et al., 2015b).

The 'data sciences' are gaining momentum and they offer opportunities for providing even better support to the search for talent. Two challenges for the research group in the upcoming period will involve linking the data files and coping with big data. In addition, the smart measuring devices currently used in the HAN Centre of Expertise for Sports, Labour and Health within the HAN Institute of Sports and Exercise Studies are the precursor to an eTalentLab. The information obtained is intended to

encourage students, lecturers and exercise professionals to think about how they can optimally prepare children and develop their broad motor skills to increase their chances of continuing with sport.

2

Shifting from theory to practice

Talent identification and talent development are inseparable from the environment in which the talent exists. In recent years, the research group has gained valuable insight concerning an optimal learning environment, good training programmes and other programmes. It has also become clear how children can be coached more efficiently and which of them should receive additional opportunities. Moreover, sporting talents are being better recognised, thus reducing the number of children who are incorrectly classified as talented ('false positives') and – even more importantly – the number of true talents who are not seen ('false-negatives').

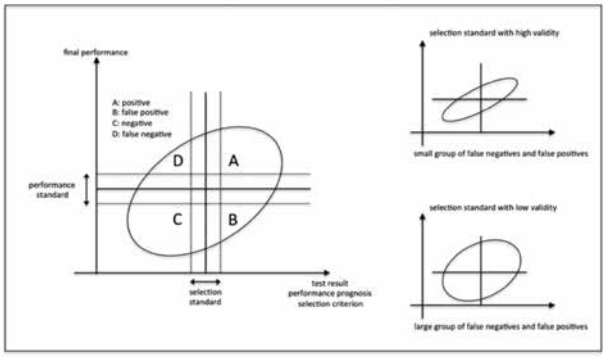

Figure 1: Risk of error in selection (following Baur, 1988)

The research group contributes to the professional field by developing knowledge and competence to improve the identification and subsequent development of talent. Those directly involved with young athletes – trainers, coaches, teachers (specialist or other), managers or parents – receive practical tools for recognising and further developing talented athletes. These tools include measuring instruments, teaching and training programmes and the associated didactic principles. The position of the HAN Institute of Sports and Exercise Studies as a university of applied sciences is unique within the partnership with the University Medical Center Groningen and Ghent University. The application of scientific methods is raising the professional level of students studying at HAN. To translate science into practice, the research group will

focus its efforts in the next period on converting the knowledge of the theoretical models and practical systems that have been discussed into a practical system supported by predictive models and artificial intelligence (Pion, 2017).

2.1. Talent detection

For some time, it has been known that the physical traits (strength, speed, endurance, agility) of children in industrialised countries have declined considerably. In a new development, the same trend is occurring in the area of general motor coordination, which is a building block for efficient learning and the performance of specific techniques. Based on results from a standardised motor coordination test, Vandorpe et al. (2011) demonstrate that the percentage of children with talent in the field of motor skills has decreased by half in the past three decades, while the number of children with motor problems has doubled. The group of potential future elite athletes from which various federations must select the majority of their future champions is thus shrinking. It is therefore not surprising that initiatives are being taken to address the talent problems at the base (i.e. detection). Attention for excellence in children is gaining more ground in education. This is true for the core subjects, as well as for physical education. In 2013, the sector organisation for primary education in the Netherlands (the PO Raad) indicated that the primary education system is in need of instruments and programmes for recognising talent in children. Even in physical education, little attention has traditionally been paid to children who are capable of more than their peers. One common philosophy was that 'they will manage in sport'. Based on the idea that not every child has the same capabilities but deserves the same opportunities, a change has been observed in recent years (Platvoet, Elferink-Gemser, & Visscher, 2010). This means that children should receive support that is more tailored to their needs. Understanding current performance levels and the potential of children to perform in the future is essential. Such insight offers specialist teachers and trainers/coaches the possibility of charting the talent of each child in a more reliable and valid manner and then offering the right programmes to further develop this talent.

What does the research group offer in terms of talent detection?

Detecting children with superior motor skills is of primary importance. The 'Eye for Excellence' project measures the motor levels of children in primary schools based on four simple tests, including the KTK short form (Novak et al., 2016), a perceptual-motor test (Faber, 2014) and a potency estimation by the Physical education teacher (Platvoet, Elferink-Gemser, Baker and Visscher, 2015). Based on the results achieved, children are divided into level groups and offered customised motor programmes, which also include the incentives needed to encourage those with better motor skills to develop further. Those with less motor talent are also challenged at their own level. In recent years, the Research Group for Talent Identification and Development in Sports has worked to develop a talent scan that can be used to recognise each child's talent. Programmes have also been created for developing these talents.

Physical education teachers are the first link in guiding talent. The information collected at primary schools is beneficial for children's choice of sport and can be linked to other data. For example, the benefits of such a link were demonstrated in a recent study in which 121 primary school children and 146 age peers from table tennis clubs completed the same perceptual-motor test battery (Faber, Munivrana, Pion et al., 2017). The results indicated that 28% of the children tested in the primary schools possessed the qualities needed to play table tennis. They also indicated that 2% of these children could belong to the better table tennis players, even without specific training.

2.2. Talent orientation

In Dutch society, sports and exercise are clearly important. Nevertheless, a relatively large number of children quit sport upon entering secondary school, thereby making life-long exercise more difficult. Loss of pleasure in the sport is one of the most important factors explaining this loss, but what causes children to lose pleasure in sports? Does this affect the choice of sport and, if so, how much?

Being able to recognise children with better motor skills was demonstrated by the motor test battery offered to schools for detecting these children. An extension to this test battery is the Sportkompas, a generic test battery consisting of 16 tests. These tests have provided insight into a broad spectrum of talent identification and talent

development. The orientation of talent through motor giftedness, physical traits and exercise preferences should in no way be regarded as synonymous with assigning children to particular sports for purposes of early specialisation. Training history bears a major influence on sport-specific profiles. According to a study by Opstoel et al. (2015), in which 627 children (aged 9-11 years) were measured using the Sportkompas, children can be assigned to the following sports clusters at a young age: ball sports, dance, gymnastics, martial arts, racket sports and swimming. Of the children who were already active in sports for several hours per week (n > 5 h/week), 85% could be placed in the appropriate cluster, whereas only 48% of the children who were active no more than one hour per week were recognised in the corresponding sports cluster. The same generic test battery was administered to trained athletes, resulting in a 96% correct classification into nine different sports: badminton, basketball, handball, judo, gymnastics, table tennis, triathlon, soccer and volleyball (Pion et al., 2015c). Results from a follow-up study indicate the test battery can even be applied to related sports. For boys younger than 13 years of age and for boys younger than 18, the researchers were able to assign all of the combat sport athletes to their correct sports (i.e. karate, taekwondo or judo) (Pion et al., 2014).

What does the research group offer in terms of talent orientation?

Smart Sports Choice (in Dutch, Slimme Sportkeuze) was designed to help children choose sports they will enjoy. Proceeding from the self-determination theory (Ryan & Deci, 2000), it is well-known that children become motivated when they experience success, involvement and autonomy in sport. This raises questions about how to assist children in choosing sports that match their own traits and preferences.

After detection at school, the results can be further supplemented with the online App that measures preferences. The Flemish Sport Compass (FSC) measures what children LIKE TO DO as well as what they CAN DO WELL (Pion, 2015d). This brings us to the next stage, which allows a validated test battery based on 16 generic tests to help children in their sports choices. The HAN Institute of Sports and Exercise Studies has electronic testing equipment that can be used to guide large numbers of children in their choice of sport. Orientation to one or more sports is just one of the advantages of this tool. Even greater advantages can be realised in the future, once it becomes possible to scientifically demonstrate that sports profiles exhibit both differences and similarities. Research in the field of talent transfer indicates which sports correspond

to each other. The method was recently applied for the first time to reveal differences and similarities between basketball, football and volleyball (Pion et al., 2016) and between table tennis, tennis and badminton (Robertson et al., 2017). The similarities and differences between sports offer new opportunities in sport. Sports sampling allows children to develop broadly, thereby delaying specialisation for a time (French et al., 2012; Di Fiori et al., 2017). Although early orientation to a sport is not intended to lead to early specialisation, it is necessary to know the strengths that correspond to a cluster of sports.

2.3. Talent identification

At present, many children are either not identified or are incorrectly identified and/or not identified in a timely manner. In many sports, the percentage of athletes identified as talented who actually make it to the top is relatively low (Deprez et al., 2015; Platvoet et al., 2017). It is also likely that some children with considerable talent are not identified, due to shortcomings in the identification procedure. Furthermore, performance at a given time often plays a leading role in identification, with potential and the final level to be achieved playing a subordinate role. In other words, a gold medal in the youth division offers little guarantee of gold in the senior division (Li Pingwei, 2016).

To improve the process of talent identification, a multidimensional longitudinal study was conducted in which a fixed group of athletes with a certain frequency were measured to gain insight into the factors affecting performance. The factors considered in this process are of an anthropometric, physiological, psychological, technical/tactical and cognitive nature. The results also provide insight into the extent to which these factors can be developed. Characteristics of both the athlete and the athlete's environment are taken into account.

What does the research group offer in terms of talent identification?

In practice, training history and maturation receive little or no consideration, thereby limiting the accuracy with which potential can be estimated. As recently noted, however, the relative age effect and maturity play an important role in identifying talented athletes in several sports: handball (Matthys et al., 2013), football (Deprez 2015), tennis (Kramer et al., 2016), figure skating (Mostaert et al., 2016), sailing (Callewaert,

2015) and table tennis (Faber, 2016). In volleyball, technique plays an important role in the selection of players, in addition to height and jump height (Gabett et al., 2006). General motor skills are rarely considered in practice (Pion et al., 2015a). Strength, speed, endurance and other traits provide a snapshot of current performance condition, whereas the trainer is usually more interested in the athlete's potential. It has been demonstrated that the bias of scouts can be reduced through such simple measures as indicating the biological age of athletes through shirt numbers.

Practical case 1: Talent identification in volleyball

The Dutch Volleyball Federation (abbreviated in Dutch to NEVOBO) has asked the HAN Institute of Sports and Exercise Studies to contribute knowledge and expertise to the 'What's your talent?' project subsidised by the Ministry of Health, Welfare and Sport. The project has two objectives: to generate enthusiasm for volleyball amongst boys aged 13-15 years and to detect volleyball talent in schools. Given the first objective, NEVOBO has opted to train a large group for a period of 10 weeks following an initial selection based on the Scale for Identification of Sport Potential (SISP). Only after this first training period is a test battery applied in order to determine who will qualify for a follow-up programme.

2.4. Talent development

Like other subjects, physical education is a learning subject. If parents, science and the development of the exercising child are to be taken seriously, specialist physical education teachers should bear primary responsibility for guiding children, both at school and in sports associations (De Greef, 2016). At school, it is possible to follow the child's learning process, thereby arriving at a structured and age-related construction of exercise topics. Moreover, the secure and trusted pedagogic climate makes it possible to reach all children, including those with weaker and stronger motor skills. Good motor skills contribute to remaining physically active later, in addition to being a condition for becoming good at a sport (Catuzzo, 2014). Studies have demonstrated the existence of a transfer effect between different sports and that a base of many different sports tends to overlap with exercise skills that contribute to a broad motor foundation (Tenenbaum & Eklund, 2007). We have since learned that the myth of early specialisation as the only path to success for many sports is obsolete and that providing a diverse array of exercise opportunities at a young age can be a good alternative route, which also reduces the likelihood of injury and attrition from the sport later in life

(Goodway & Robinson, 2015; Di Fiori et al., 2017). Fransen et al. (2012) examine the difference between early specialisation and 'playing many sports' at a young age. The results of the generic test battery and the survey about sports participation amongst the 735 boys included in the study revealed an acute positive effect of the number of hours of sports per week and a latent positive effect for playing multiple sports.
Sports federations and clubs are also in need of tools for discovering talented athletes at a young age. The earlier gifted children are identified, the earlier they can start participating in talent-development programmes. Targeted training requires both quality and quantity and the ability to reach the highest level after many years depends upon the type and intensity of the training and the amount of pleasure realised in the sport. 'Deliberate practice' requires time, energy, equipment and trained instructors, and it is not necessarily fun to do (Ericsson and Lehmann, 1996).

What does the research group offer in terms of talent development?

Physical education classes are the preferred environment in which to challenge children and provide them with a diverse range of opportunities for exercise. In these classes, every child can lay a foundation for future activity in the context of sports. This requires children to learn to exercise and be all-rounders in sport. At present, however, physical education in primary schools is characterised by classes in which the motor level of the students varies widely. The tendency to see the actual activity – and not the motor development of the unique child – as the goal clearly indicates that the activity levels of students are likely to come under pressure. One of the goals of the RAAK project entitled 'Recognising motor talent: Eye for Excellence' is to establish a programme to develop the activity level of children with motor talent. The programme focuses on the coordination capacities described in the Athletic Skills Model (Wormhoudt, Teunissen, & Savelsbergh, 2012).

Practical case 2: Differentiation in the range of motor opportunities

In cooperation with the Foundation for Curriculum Development (in Dutch, Stichting voor Leerplan Ontwikkeling, or SLO) a card catalogue of classroom activities has been developed for children in Groups 3-6 who have been recognised as having motor talent. For 10 weeks, these activities are offered at random by a physical education teacher through a revolving system in three subjects, in one of which the teaching activities are offered to children with motor talent. The classroom activities focus on differences in level between children with motor talent within the same school as well as on differences between children with motor talent at different schools. For example, coupling power (coordination in synchronising one's own body parts) of a child in Group 3/4 could be increasingly challenged with the balloon-dance activity. The simplest assignment is to keep a balloon in the air in pairs using a racket. The most complex assignment is to keep two balloons of different colours (possibly filled with marbles) in the air by taking turns hitting them.

It is also very important to chart the visions of the various sports associations and plot them against each other. The HAN Institute of Sports and Exercise Studies is committed to working with the municipalities, the province and Topsport Gelderland to create an environment in which this is possible. Moreover, proceeding from a shared vision, efforts can be directed towards broad motor development at a young age.

Practical case 3: Combi-membership

For club-related sport, combination memberships could be a way of developing a basis in different sports. In this regard, it would be advisable to proceed from the common denominators within the various sports. The sports could be broken down individually according to agreements scientifically demonstrated through the Sportkompas, along with coordination capacities, proceeding from the basic forms of movement in the Athletic Skills Model. 'Transfers' should be sought based on exercise-related reasons to examine the child's development from multiple angles. The partner organisations could offer a joint membership, thereby offering children the option of choosing a target sport for adding depth and breadth to the skills that have been developed in a variety of different sports. Motor development will be accelerated through the training of multiple motor skills through different sports. Learning all the basic forms of movement within the various skills (sports) calls for the development of adaptability.

In recent years, efforts have also been focused on the principles for creating an optimal educational and methodological climate, with specific attention to self-regulation. Talented athletes spend considerable time and energy improving their skills, with the goal of attaining the highest possible achievement. It is thus also necessary for them to learn and train effectively. The athletes who use self-regulation – those who reflect on their learning process, set performance and process goals and create action plans, in addition to monitoring and evaluating their learning processes – generally develop faster than athletes who make less use of these skills, because they learn more efficiently (e.g. Cleary & Zimmerman, 2001; Elferink-Gemser, de Roos, Torenbeek, Fokkema & Jonker, 2013). The application of science in practice provided a foundation for improving the development of motor skills, motivation and confidence in one's own abilities and self-regulation behaviour, in addition to focus during PE class or training.

Practical case 4: Self-regulation as a resource for talent development

The principles of self-regulation in sports practice (ZIPcoach) have been incorporated into the curricula of the HAN Institute of Sports and Exercise Studies (Idema & Torenbeek, 2015). Students are implicitly trained in the principles during the first 2.5 school years, thereby developing their self-regulation skills. The developed ZIPcoach intervention translates the research on self-regulation in sports and education into practice: in both education and in recreational and elite sport. In the last 1.5 years of their degree courses, students choosing the Talent team learn to apply these principles themselves, so that the pupils they teach in PE lessons will also progress in their application of self-regulation skills.

3

Building a customised talent system

3.1. Detect first, then identify

Sports federations around the world invest in talent identification to select athletes. The disadvantage of selecting for development programmes is that potential can also be lost through non-selection. This touches directly upon the interests of a much broader group, and perhaps all children. They also stand to benefit from a good sports programme, and they should receive customised programmes or the option of selecting sports that suit them. Knowledge developed in the area of elite sport also strengthens recreational sports, which subsequently serves to reinforce the elite level. The process of optimising sports and exercise programmes for the purposes of elite sport can thus be simultaneously reinforced and improved in terms of organisation by ensuring that it benefits as many children as possible. The talent identification processes currently applied separately in each sports federation are in need of adjustment. A joint approach at the base is needed. The common detection phase in schools offers opportunities to advance the talent identification systems in sports federations. In addition, accurate predictions could make it possible to make the right choices. The advantage of this is that the amount of talent lost is reduced and development costs are better deployed. Detecting children with potential is the first step towards developing talent. Attention is usually directed only towards children who are developing more slowly, to ensure that everyone reaches the average activity levels. If we wish to teach all children to exercise well, we should (must) also pay attention to the children who demonstrate very good motor skills.

Practical case 5: Project 'Recognised Talent: Eye for Excellence'

It is important for children to discover at an early age which sports are best suited to them. The project 'Recognised Talent: Eye for Excellence' takes lessons from the 'Flemish Sports Compass (FSC)', which was implemented with the aim of providing all children in primary school with an orientation to sports that suit their individual capabilities (Pion 2015d). The FSC allows children to choose sports that suit their anthropometric, physical and motor qualities, with the underlying aim of allowing them to enjoy sport and ensuring that fewer of them drop out later in life. The talent consortium formed between HAN, University Medical Center Groningen and Ghent University, and which was supported by the Research Centre on Sport, aims to achieve a change of course in talent development, focusing on getting children involved in sports that suit their capabilities.

3.2. A strong talent system for a small country

It is natural for a small country to treat the available talent with great care. One challenge associated with a smaller talent pool involves losing as few gifted children as possible to the sport. For this reason, an integrated system is needed that keeps the costs as low as possible (Pion, 2017). More specifically, it is much easier to detect the talents of all children in small countries than it is in large countries. Although the percentage of talented children is likely to be about the same, a small talent pool does offer the possibility to screen everyone, instead of merely a select group from within the sports association. We would thus do well to turn a weakness into strength by establishing a connection between physical education in primary schools and the efforts of sports professionals in clubs.

3.3. Develop broadly and specialise later

To ensure optimal **development**, children should be given as many incentives as possible. In the international literature, early **specialisation** is regarded as less favourable (Fransen et al., 2012; Suppiah et al., 2015; DiFiori et al., 2017) but it should also not prevent talented children from developing within a particular sport at a young age.
Although playing sports in clubs is important to achieving success in the future, specialisation is unnecessary, and it can even be harmful to long-term success (Di Fiori et al., 2017). The authors support the **multi-sport approach**, noting that playing with friends can promote transfer to later specialisation. The debate between proponents

and opponents of early specialisation and a versatile development model has generated a clear distinction between the advantages and disadvantages of the two pathways to top performance (Bompa & Haff, 2009). Early specialisation accelerates performance improvement and premature peak performance at an age of 15-16 years (Bompa & Haff, 2009). Nevertheless, athletes who specialise early often suffer from burn out due to the repetitive nature of 'deliberate practice' (Gould, Tuffey, Udry & Loehr, 1996) and a decrease in intrinsic motivation and fun during training sessions (Wall & Côté, 2007). As documented by Malina et al. (2010), early specialisation can lead to over-dependence and increased risk of sports injuries in young athletes. Young athletes who develop broadly reach their peak performance at a slightly slower rate and a slightly later age (Baker, Côté & Abernethy, 2003), but they tend to have fewer injuries (Bompa & Haff, 2009) and to be less likely to drop out (Fraser-Thomas, Côté & Deakin, 2008), as compared to athletes who specialise early, due to a more gradual process of physical and psychological development (Côté et al., 2009). In addition, players who developed broadly tend to have longer sports careers (Baker et al., 2005). In 2000, the American Academy of Pediatrics (2000, p1 line 7-14) proposed the following: 'Children involved in sports should be encouraged to participate in a variety of different activities and develop a wide range of skills'.

3.4. Schools and clubs in search of talent

Schools, municipalities and clubs are currently investing in their own independent projects for an active society. These parties are also searching for the talents of these children, to ensure they are optimally prepared for life. This should, of course, take place within a safe pedagogic environment, which requires well-qualified staff in the sports club. It is in the interests of potential medal winners to be detected early and to have every opportunity to develop. For the talent pay off, the primary focus is currently on the development of the athletes four (4) and, in the best case, eight (8) years prior to the podium. To make this pool as wide as possible, however, it is important to take action 12 and 16 years prior to the podium, in order to use enjoyment in sport and broad motor development to provide children with every opportunity to develop a lifelong sports career and, possibly, to be able to excel. It is therefore important to draw connections between the efforts made at every level. While non-sports organisations are unlikely to be motivated to contribute to winning sports medals, the situation is likely to be quite different for the interest of the group as a whole. It offers additional benefits for reducing drop-out rates and facilitating transfers between sports.

4

Connecting talent research with education and the professional field

The Research Group for Talent Identification and Development in Sports focuses on profiling and positioning the HAN Institute of Sports and Exercise Studies as the **premier** knowledge institute in the area of talent identification and development in the EUREGIO. The use of an inquiring attitude is an important instrument in this regard. The research group focuses on the **triangle of research – education – professional field**. The practice-based and applied research is of high quality, with a clear translation to practice. It can also lead to international and national publications in leading international journals and magazines. Examples include a PhD study on the role of teachers in sports and physical education with regard to recognising athletic talent and publications on the public network through blogs (e.g. Gouden Kansen [Golden Opportunities]). Knowledge developed within the research group is conducted primarily in response to questions/needs from the field. Where possible, students play an important role in the design and implementation of the practice-based research. The developed knowledge is translated directly to the professional degree courses of the HAN Institute of Sports and Exercise Studies. The dual appointment (i.e. as researchers and lecturers) of all members of the network makes this relatively easy to achieve. The research group would also like to contribute to the scientific literature. This task is facilitated through collaboration with University Medical Center Groningen, Ghent University and VU Amsterdam within the Sports & Talent network. The network makes it easier to apply for grants within a consortium, which is currently a necessary condition. With these efforts, the research group is making an important contribution to HAN's profile as a university of applied sciences.

4.1. Connection to the professional field: Slimme Sportkeuze (Smart Sports Choice)

The further strengthening of collaboration between HAN, the province of Gelderland and the municipal sports services (including those in Arnhem and Nijmegen, Zwolle and Deventer), schools, sport associations and clubs in the region is high on

the research group's wish list. This ties in with the objectives of the National Knowledge Agenda for Sport and Exercise to involve sports practitioners in research and to incorporate the results through a proactive network and innovation. The Slimme Sportkeuze (Smart Sports Choice) project aims to support work within the field and to collaborate in the development of practical tools. These efforts are closing the gap between the school and the club by introducing children to sports in a variety of ways, thereby forging a connection between the education system and the sports associations. One example involves consultation services provided to football clubs Vitesse, FC Twente and PSV with regard to the identification and development of the youngest players in the youth academy. The province of Gelderland would like to develop a Gelderland-specific model of talent development, which has already been elaborated into a project in which the municipalities of Arnhem and Nijmegen will work with the research group and Topsport Gelderland on optimising the developmental environment for the unique sports/exercise talent of every child. For example, in the municipality of Nijmegen, the school boards are collaborating with the municipality to develop an exercise agenda in order to realise the greatest possible benefit from all efforts. Neighbourhood sports coaches and schools are joining forces to expand a rich developmental environment for all children, with efforts focusing on the talents of all children.

4.2. Scientific measuring instruments: I like App

The programmes are supported by measuring instruments for charting the activity levels and the sport preferences of children. Today, we are presenting the municipalities with an instrument to get children to start exercising in a sport that best suits their preferences and abilities. The knowledge for the App was distilled from research conducted at Ghent University and its translation from science into practice was supported by the HAN Institute of Sports and Exercise Studies. The 'I like' module of the Sportkompas is an App that takes the child on a space excursion through sport planets, in order to identify sports within the child's sphere of interest, based on 'exercise preferences'. The information obtained indicates what children LIKE TO DO. The instrument is ready to use. Starting today, specialist sports and physical education teachers and sports instructors in the municipalities of Gelderland and elsewhere can provide even better guidance to children in making an actual choice for a sports club. The information obtained from the Sportkompas concerning individual sports preferences can also be linked to the measurements taken at school within the framework

of the detection phase, in which activity levels were evaluated by specialist teachers. The App can thus be regarded as an instrument for use by specialist teachers in primary schools, neighbourhood sports coaches in municipalities and trainers at sports clubs. One important assignment for the Research Group for Talent Identification and Development in Sports involves the further validation of the talent-identification instruments and talent-development programmes for primary school children. There is also a role for interdisciplinary research, with big data and data science playing a prominent role in the research group's future practice-based research.

4.3. Translating science to education

The knowledge obtained from this research supports specialist physical education teachers in their efforts to recognise children with talent for a particular sport. By devoting attention to talent, HAN is distinguishing itself from other universities of applied science that offer degree courses in sports. Students studying at the HAN Institute of Sports and Exercise Studies are exposed to insights developed by the Research Group for Talent Identification and Development in Sports in all academic years, and they are taught how to apply these insights in practice. In this way, the research group is responding to developments in society as a whole, and specifically in the field of education, thereby preparing students well for future professional requirements. Practical feasibility is guaranteed by establishing this type of introductory process for exercise professionals in sports companies and municipalities right from the start. This approach also improves the supervision of the students of the HAN Institute of Sports and Exercise Studies who are doing work placements within these organisations, thus allowing knowledge transfer to take place in both directions.

4.4. Talent research in practice

The knowledge obtained from the research conducted from the Research Group for Talent Identification and Development in Sports can be returned to students directly through their degree course. This knowledge is also used directly in practice to support sports organisations and sports federations. That can occur during scouting efforts, in the design of scouting instruments or through monitoring the development and behaviour of children during training and competitions. Other examples include determining the effectiveness of training sessions on personal qualities or determining whether this plays a role in the selection (or non-selection) of children and in

policy formation with regard to processes of talent identification and development. Important insights stand to be gained by tracking the development of children in cooperation with the physical education practitioners and students. This is in the interest of Dutch society, the education system (including physical education). Moreover, it does justice to the individual capabilities of each child. In this way, we are working to realise in practice the dream that launched this research group and to make sustainable investments in sports talent through schools and clubs.

Reference list

Abbott A., Collins D. (2004). Eliminating the dichotomy between theory and practice in talent identification and development: Considering the role of psychology. *Journal of Sports Sciences*, 22, p. 395–408.

Baker J., Côté J. & Abernethy B. (2003). Sport-specific practice and the development of expert decision-making in team ball sports. *Journal of Applied Sport Psychology*, 15(1), p. 12-25.

Baker, J., Côté, J., & Deakin, J. (2005). *Expertise in ultra-endurance triathletes early sport involvement, training structure, and the theory of deliberate practice. Journal of Applied Sport Psychology*, 17(1), 64-78.

Balyi I., Hamilton A. (2004). Long-term athlete development: Trainability in childhood and adolescence. *Olympic Coach*, 16(1), p. 4-9.

Bar Or O. (1975). Predicting athletic performance, *Physician and sports medicine* 3 (2): p. 81-85.

Baur, J. (1988). Talentsuche und talentforderung im Sport 1, Leistungssport 18 (2): p. 5-10.

Bergeron, M. F., Mountjoy, M., Armstrong, N., Chia, M., Côté, J., Emery, C. A., & Malina, R. M. (2015). International Olympic Committee consensus statement on youth athletic development. *British Journal of Sports Medicine*, 49(13), p. 843-851.

Bloom B.S. (1985). Developing talent in young people. New York: Ballantine, 1985.

Bompa T., Haff G. (2009). *Periodization: Theory and methodology of training*. Human Kinetics Publishers.

Bouchard, C., Malina, R. M., & Pérusse, L. (1997). *Genetics of fitness and physical performance*. Human Kinetics.

Bullock N., Gulbin J.P., Martin D.T., Ross A., Holland T. & Marino F. (2009). Talent identification and deliberate programming in skeleton: Ice
novice to Winter Olympian in 14 months. Journal of sports sciences, 27(4), p. 397-404.

Callewaert, M., Boone, J., Celie, B., De Clercq, D., & Bourgois, J. G. (2015). Indicators of sailing performance in youth dinghy sailing. *European journal of sport science*, 15(3), p. 213-219.

Cattuzzo, M. T., dos Santos Henrique, R., Ré, A. H. N., de Oliveira, I. S., Melo, B. M., de Sousa Moura, M., ... & Stodden, D. (2016). Motor competence and health related physical fitness in youth: A systematic review. *Journal of Science and Medicine in Sport*, 19(2), 123-129.

Côté J, & Fraser-Thomas J (2007). *The health and developmental benefits of youth sport participation*. Toronto: Pearson.

Coté, J., Horton, S., MacDonald, D., & Wilkes, S. (2009). The benefits of sampling sports during childhood. *Physical & Health Education Journal*, 74(4), p. 6.

Csikszentmihalyi M., Rathunde K., Whalen S. (1993). Talented teenagers: *The roots of success and failure*. New York: Cambridge University Press.

Davids, K., & Baker, J. (2007). Genes, environment and sport performance. *Sports medicine*, 37(11), p. 961-980.

Deprez D., Buchheit M., Fransen J., Pion J., Lenoir M., Philippaerts R., Vaeyens, R.. A longitudinal study investigating the stability of anthropometry and soccer-specific endurance in puberal high-level youth soccer players. (2015) Journal of Sports Sciences and Medicine, 8; 14(2): p. 418-426.

Di Fiori, J. P., Brenner, J. S., Comstock, D., Côté, J., Güllich, A., Hainline, B., & Malina, R. (2017). Debunking early single sport specialisation and reshaping the youth sport experience: an NBA perspective.

Ericsson K.A., Krampe R.T. & Teschromer C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100(3), p. 363-406.

Ericsson, K. A., & Lehmann, A. C. (1996). Expert and exceptional performance: Evidence of maximal adaptation to task constraints. *Annual review of psychology*, 47(1), p. 273-305.

Elferink-Gemser M.T., Visscher, C. (2012). Who are the superstars of tomorrow? Talent development in Dutch Soccer. In J. Baker, J. Schorer, S. Cobley (Eds). Talent identification and development in sport. International perspectives (pp. 95-105). London: Routledge.

Ford P., De Ste Croix M., Lloyd R., Meyers R., Moosavi M., Olive J., Tiill K. & Williams C. (2011). The Long Term Athlete Development model: Physiological evidence and application, *Journal of Sports Sciences*, 29:4, p. 389-402.

Faber, I. R., Oosterveld, F. G., & Nijhuis-Van der Sanden, M. W. (2014). Does an eye-hand coordination test have added value as part of talent identification in table tennis? A validity and reproducibility study. *PloS one*, 9(1), e85657.

Faber, I. R., Elferink-Gemser, M. T., Faber, N. R., Oosterveld, F. G., & Nijhuis-Van der Sanden, M. W. (2016). Can Perceptuo-Motor Skills Assessment Outcomes in Young Table Tennis Players (7–11 years) Predict Future Competition Participation and Performance? An Observational Prospective Study. *PloS one*, 11(2), e0149037.

Faber, I.R., Munivrana, G., Pion, J. (2017), Does a perceptuomotor skills assessment have added value to detect talent for table tennis in primary school children?, Journal of Sport Sciences (submitted, February 2017)

Fransen J. *, Pion J.*, Vandendriessche J., Vandorpe B., Vaeyens R., Lenoir M. and Philippaerts R. Differences in physical fitness and gross motor coordination in boys aged 6-12 years specializing in one versus sampling more than one sport. (2012) Journal of Sport Sciences 30(4), p. 379-386.

Fraser-Thomas, J., Côté, J., & Deakin, J. (2008).Understanding dropout and prolonged engagement in adolescent competitive sport. *Psychology of Sport and Exercise*, 9, 645-66.

Gabbett, T., Georgieff, B., Anderson, S., Cotton, B., Savovic, D., & Nicholson, L. (2006). Changes in skill and physical fitness following training in talent-identified volleyball players. *The Journal of Strength & Conditioning Research*, 20(1), 29-35.

Gabler H., Ruoff B.A. (1979). Zum problem der Talentbestimmung im Sport, *Sportwissenschaft* 9 (2) : p. 164-180.

Gagné F. (2004). Transforming gifts into talents: the DMGT as a developmental theory. *High Ability Studies*, 15(2): p. 119-147.

Geron E. (1978). Psychological assessment of sport giftedness, in Simri U (ed.), *Proceedings of the international symposium on psychological assessment in sport*, Nataya : Wingate Institute, p. 216-231.

Goodway, J. D., & Robinson, L. E. (2015). Developmental trajectories in early sport specialization: a case for early sampling from a physical growth and motor development perspective. *Kinesiology Review,* 4(3), 267-278.

Gould, D., Tuffey, S., Udry, E., & Loehr, J. (1996). Burnout in competitive junior tennis players. Qualitative analysis. Sport Psychologist, 10(4), 341 - 366.

Gulbin, J., Weissensteiner, J., Oldenziel, K., & Gagné, F. (2013). Patterns of performance development in elite athletes. *European journal of sport science*, 13(6), p. 605-614.

Harre D. (1982). *Trainingslehre*. Berlin: Sportverlag.

Heller K. (2004). Identification of Gifted and Talented Students, *Psychology science*, Volume 46, (3), p. 302-323.

Hohmann A. (2009). *Entwicklung Sportlicher Talente an Sportbetonten Schulen, Shwimmen-Leichtathletik-Handball*, Michael Imhof Verlag. Gmbh&Co.KG, Petersberg.

Hopkins, W. G., & Hewson, D. J. (2001). Variability of competitive performance of distance runners. *Medicine and Science in Sports and Exercise*, 33(9), p. 1588-1592.

Howe, M. J., Davidson, J. W., & Sloboda, J. A. (1998). Innate talents: Reality or myth? Behavioral and brain sciences, 21(03), p. 399-407.

Hungermann J., Viele ehemalige DDR-Leistungssportler können kaum noch stehen. (2006). [Cited 2006 22 November] Available from: http://www.welt.de/sport/article96480.

Johnson, M. B., Tenenbaum, G., & Edmonds, W. A. (2006). Adaptation to physically and emotionally demanding conditions: The role of deliberate practice. *High Ability Studies*, 17(1), p. 117-136.

Jones G. (2008). China's Olympic plan to topple America [cited 2008 1 august] Available from: http://www.thefirstpost.co.uk/45023,news politics, chinas 119 olympic dreams.

Jones J.G., Watson G.G. (1977). Psychological factors in the prediction of athletic performance, in Simri U (ed.), *Proceedings of the international symposium on psychological assessment in sport*, Nataya: Wingate Institute, p. 89-102.

Kinugasa T. (2014). Talent Identification Conference "Identifying Champions" April 2nd – 3rd 2014. "Targeting Tokyo 2020 and beyond/ The Japanese TID model".

Kiphard E.J., Schilling F. Körperkoordinationstest für Kinder 2. Überarbeitete und ergänzte Auflage. Weinheim: Beltz: Test GmbH. 2007.

Klissouras, V. (1971). Heritability of adaptive variation. *Journal of Applied Physiology,* 31(3), 338-344.

Kramer, T., Huijgen, B. C., Elferink-Gemser, M. T., & Visscher, C. (2016). A longitudinal study of physical fitness in elite junior tennis players. *Pediatric Exercise Science*, 28(4), 553-564.

Laing S. (2014). Talent Identification Conference "Identifying Champions" April 2nd – 3rd 2014. 3 ''To the London Olympics and beyond – talent identification practices in the UK".

Li P., Pion, J, Weissensteiner, J, De Bosscher, V (2017), Is Early Success a Reliable Predictor for Senior Success in Elite Combat Sports?, submitted Journal of Sports Sciences

Malina, R. M. (2010). Maturity status and injury risk in youth soccer players. *Clinical Journal of Sport Medicine*, 20(2), 132.

Matthys S., Vaeyens R., Fransen J., Deprez D., Pion J., Vandendriessche J., Vandorpe B., Lenoir M. and Philippaerts R. A longitudinal study of multidimensional performance characteristics related to physical capacities in youth handball. (2013) Journal of Sports Sciences 31(3), p. 325-334.

Mostaert M., Deconinck F., Pion J., Lenoir M.. Anthropometry, physical fitness and coordination of young figure skaters of different levels. (2015) International Journal of Sports Medicine, Submitted August 5th 2015.

Müller E, Benko U, Raschner C, Schwameder H (2000). Specific fitness training and testing in competitive sports. *Medicine & Science in Sports & Exercise,* Vol 32, N°1, pp. 216-220.

Novak, A. R., Bennett, K. J., Beavan, A., Pion, J., Spiteri, T., Fransen, J., & Lenoir, M. (2016). The Applicability of a Short Form of the KörperKoordinationsTest für Kinder for Measuring Motor Competence in Children Aged 6-11 Years. *Journal of Motor Learning and Development*, p. 1-20.

Opstoel K.*, Pion J.*, Elferink-Gemser M., Hartman E., Willemse B., Philippaerts R., Visscher C., Lenoir M.. Anthropometric, Physical fitness and motor coordinative characteristics of 9 to 11 year old children participating in a wide range of sports. (2015) PlosOne, Published May 15, 2015, DOI: 10.1371/journal.pone.0126282.

Papic V, Rogulj N, Plestina V (2009), Identification of sport talents using a web oriented expert system with a fuzzy module. *Expert Systems with application*, Vol. 36, pp. 8830-8838.

Pion J., Fransen J., Lenoir M., Segers V. The value of non-sport-specific characteristics for talent orientation in young male judo, karate and taekwondo athletes. (2014) Archives of Budo (10), p. 147-152.

Pion J. *, Fransen J.*, Deprez D., Segers V., Vaeyens R., Philippaerts R., Lenoir M. Stature and jumping height are required in female volleyball, but motor coordination is a key factor for future elite success. (2015a) Journal of Strength and Conditioning Research, 29(6), p. 1480 – 1485.

Pion J. *, Lenoir M. *, Vandorpe B. and Segers V. Talent in female gymnastics: a survival analysis based upon performance characteristics. (2015b) International Journal of Sports Medicine 36: p. 935-940, DOI/10.1055/s-0035-1548887.

Pion J., Segers V., Fransen J., Debuyck G., Deprez D., Haerens L., Vaeyens R., Philippaerts R., Lenoir M.. Generic anthropometric and performance characteristics among elite adolescent boys in nine different sports. (2015c). European Journal of Sport Science, 15(5), p. 357-366.

Pion, J. (2015d). *The Flemish sports compass: From sports orientation to elite performance prediction* (Doctoral dissertation, Ghent University).

Pion J.*, Hohmann A.*, Liu T., Lenoir M., Segers V. Predictive models reduce talent development costs in female gymnastics. (2017) Journal of Sports Sciences, 35 (8), p. 806 – 811.

Platvoet, S.W.J., Elferink-Gemser, M.T. & Visscher, C. (2010). Sporttalent Herkend. *Lichamelijke Opvoeding*, 5, 6-9

Platvoet, S.W.J., Elferink-Gemser, M.T., Baker, J., & Visscher, C. (2015). PE teachers' perceptions of sport potential: development of scale for identification of sport potential (SISP). *Annals of Research in Sport and Physical Activity*, 6, 63 - 79. doi: 10.14195/2182-7087_6_4

Platvoet, S.W.J., Opstoel, K., Pion. J. Elferink-Gemser, M.T., & Visscher C. (2017). Characteristics of players selected for the under eleven of a youth soccer academy. Journal of sport sciences (submitted)

Régnier G., Salmela J. and Russell S.J. (1993). Talent detection and development in sport. In Singer, R.N.; Milledge, M. & Tennant, L.K. *Handbook of research on sport psychology*, p. 290-313. New York: Macmillan Publishing Company.

Rose, R. J. (1995). Genes and human behavior. *Annual review of psychology*, 46(1), p. 625-654.

Ryan, R.M., Deci, E.L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55, 68-78.

Suppiah, H. T., Low, C. Y., & Chia, M. (2015). Detecting and developing youth athlete potential: different strokes for different folks are warranted. *British journal of sports medicine*, 49(13), p. 878-882.

Tenenbaum, G., & Eklund, R. C. (Eds.). (2007). *Handbook of sport psychology.* John Wiley & Sons.

Tucker, R., & Collins, M. (2012). What makes champions? A review of the relative contribution of genes and training to sporting success. *British Journal of Sports Medicine*, bjsports-2011.

Tucker R. (2014) Talent Identification Conference "Identifying Champions" April 2nd – 3rd 2014. "The talent equilibrium: Finding balance between scientific prudence and strategic prerogatives".

Vaeyens R, Gullich A, Warr CR, Philippaerts R (2009). Talent identification and promotion programmes of Olympic athletes. *Journal of Sports Sciences*, 27(13): p. 1367-1380.

Vandorpe B, Vandendriessche J, Lefèvre J, Pion J, Vaeyens R, Matthys S, Philippaerts R and Lenoir M. The KorperkoordinationsTest fur Kinder: reference values and suitability for 6-12-year-old children in Flanders. (2011) Scandinavian Journal of Medicine and Science in Sports. 21(3), p. 378-388.

Vandorpe B., Vandendriessche J., Vaeyens R., Pion J., Lefevre J., Philippaerts R. and Lenoir M.,The value of a non-sport-specific motor test battery in predicting performance in young female gymnasts. (2012a) Journal of Sport Sciences 30(5), p.497-505.

Vandorpe B., Vandendriessche J, Vaeyens R, Pion J, Lefevre J, Philippaerts, R. and Lenoir M. Factors discriminating gymnasts by competitive level. (2012b) International Journal of Sports Medicine 32(8), p. 591-597.

Wall M. & Côté J. (2007). Developmental activities that lead to dropout and investment in sport. *Physical education and sport pedagogy*, 12(1), p. 77-87.

Williams AM & Reilly T (2000). Talent Identification and development in soccer. *Journal of Sports Sciences*, 18 (9): p. 657-667.

Wolkow W.M. (1974). Aktuelle Biologische Frage der sportlichen Auslese, *Leistungssport* 4 (6): p. 469-472.

Wormhoudt, R., Teunissen, J.-W., & Savelsbergh, G.J.P. (2012). *Athletic skills model voor een optimale talentontwikkeling*. ARKO publishers.

Sustainable investment in sports talent

The path to the podium through the school and the sports club

Lector dr. Johan Pion

Physical education teachers and trainers at sports clubs both need instruments for identifying children's talent. During his speech, Professor Johan Pion discusses how the insights of physical education teachers can contribute to the challenges of detecting, identifying, exploring and developing talent. The collaboration between school and sports club is still uncharted territory. HAN supports this collaboration through the development of various 'HAN-talent-tools' such as the presentation of an app.

The research group contributes to the professional field by developing knowledge and competences to improve the identification and subsequent development of talent. Trainers, coaches, teachers, managers and parents who are directly involved with young athletes receive practical tools for identifying and further developing talented athletes. These tools include measuring instruments, teaching and training programmes and the associated didactic principles.

Students at the HAN Institute of Sports and Exercise Studies directly profit from the knowledge and insights gained by the research group. Knowledge is also transferred to other HAN departments, sports bonds, and to the professional field and the business world through specialist courses.

Johan Pion is professor of Talent Identification and Development in Sports at HAN University of Applied Sciences. He is also a member of the academic staff at Ghent University in Belgium, where he obtained his doctorate for the research project entitled 'The Flemish Sports Compass: from sports orientation to elite performance prediction'.

The interaction between science and elite performance has been a common thread throughout Dr Pion's career. He has years of experience in education, research and services at three Flemish universities. He has also made his mark in the areas of national sports promotion and training for elite and other trainers. For 25 years, he has been making his knowledge available to the Belgian gymnastics community. Johan Pion began as a professor at the HAN Institute of Sports and Exercise Studies in 2016. He leads the research conducted by the expertise team on the early identification and development of talent in sports.

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