An Australian perspective on talent identification and development in soccer

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I, Kyle James Madden Bennett declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy (Sport and Exercise), in the Faculty of Health at the University of Technology Sydney. This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used is indicated in the thesis. This document has not been submitted for qualifications at any other academic institution. This research is supported by the Australian Government Research Training Program.

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Preface

The current thesis presents a collective body of studies that are published or under-review in scientific journals. Study one and two are accepted published in Science and Medicine in Football. Study three is accepted and published in Journal of Science and Medicine in Sport. Study four and five are currently in preparation for journal submission. This thesis contains a general introduction that details the state of talent identification and development research and states the key objectives for each study (chapter one). A literature review is included to provide a comprehensive overview of commonly talent identification and development measures (chapter two). The main body of research is presented in chapters' three to seven, in the form of one narrative review, and four original investigations. The general discussion provides an interpretation of the studies from a practical standpoint and details clear implications for researchers, coaches, and sporting professionals working in the talent identification and development field. The final section of this thesis is a summary of the major findings along with a guide to areas which researchers can further investigate. This thesis adopted the American Psychological Association 6th edition referencing style. All references are included in the reference list at the end of the thesis.

List of publications

Peer-reviewed journal articles

Bennett, K.J.M., Vaeyens, R., Fransen, J. (2018). Creating a framework for talent identification and development in emerging football nations. *Science and Medicine in Football*. Advanced Online Publication. doi: 10.1080/24733938.2018.1489141.

Bennett, K.J.M., Novak, A.R., Pluss, M.A., Stevens, C.J., Coutts, A.J., and Fransen, J. (2018). The use of small-sided games to assess skill proficiency in youth soccer players: A talent identification tool. *Science and Medicine in Football, 2*(3), pp. 231-236. doi: 10.1080/24733938.2017.1413246.

Bennett, K.J.M., Novak, A.R., Pluss, M.A., Coutts, A.J., and Fransen, J. (2018). Assessing the validity of a video-based decision-making assessment for talent identification in youth soccer. *Journal of Science and Medicine in Sports*. Advanced Online Publication. doi: j.jsams.2018.12.011.

Bennett, K.J.M., Pluss, M.A., Novak, A.R., Crowley-McHatten, Z., Coutts, A.J., and Fransen, J. (In Preparation). The confounding influences of sporting participation history on talent identification assessments in youth soccer.

Bennett, K.J.M., Pluss, M.A., Novak, A.R., Coutts, A.J., and Fransen, J. (In Preparation). A multifactorial comparison of Australian youth soccer players' performance characteristics.

Conference proceedings

Beavan, A., Pluss, M.A., **Bennett, K.J.M.,** Novak, A.R., and Fransen, J. (2016). The effect of small sided games bout duration on skill involvements and cognitive engagement in youth soccer players. *Exercise and Sport Science Australia – Research to Practice*. Melbourne, Australia.

Bennett, K.J.M., Novak, A.R., Dascombe, B.J., and Fransen. J. (2016). Assessing the decision-making ability of youth soccer players during various offensive video-based situations. *Exercise and Sport Science Australia's – Research to Practice.* Melbourne, Australia.

Bennett, K.J.M. (2017). The use of small-sided games to assess skill proficiency in youth soccer players. *Australian Skill Acquisition Network Conference*. Brisbane, Australia

Bennett, K.J.M., Pluss, M.A., Novak, A.R., Coutts, A.J., and Fransen, J. (2018). The stability of youth soccer player's performance characteristics after an 18-month development period. *Exercise and Sport Science Australia's – Research to Practice*. Brisbane, Australia

Statement of author contribution

The valuable contribution of each author to the studies submitted as part of this thesis (Table I).

Table I. The valuable contribution of each author to the studies submitted as part of this thesis.

	Study one			**Study two**						**Study three**				
	Kyle Bennett	Roel Vaeyens	Job Fransen	Kyle Bennett	Andrew Novak	Matthew Pluss	Christopher Stevens	Aaron Coutts	Job Fransen	Kyle Bennett	Andrew Novak	Matthew Pluss	Aaron Coutts	Job Fransen
Research design	70%	5%	25%	50%	10%				40%	50%	20%			30%
Ethics application				80%					20%	80%				20%
Subject recruitment				100%						100%				
Data collection				60%	15%	15%	10%			70%	15%	15%		
Data analysis				100%						100%				
Statistical analysis				60%					40%	80%				20%
Manuscript preparation	80%		20%	100%						100%				
Manuscript revisions		20%	80%		15%	15%	15%	20%	35%		10%	10%	30%	50%

Table I (cont'd). The valuable contribution of each author to the studies submitted as part of this thesis.

	Study four						Study five				
	Kyle Bennett	Matthew Pluss	Andrew Novak	Zachary Crowley-McHattan	Aaron Coutts	Job Fransen	Kyle Bennett	Andrew Novak	Matthew Pluss	Aaron Coutts	Job Fransen
Research design	60%					40%	70%				30%
Ethics application	80%					20%	80%				20%
Subject recruitment	80%			20%			100%				
Data collection	55%	25%	5%	15%			60%	15%	25%		
Data analysis	60%	40%					90%		10%		
Statistical analysis	70%					30%	30%				70%
Manuscript preparation	100%						100%				
Manuscript revisions		15%	15%	5%	20%	45%		10%	10%	30%	50%

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List of abbreviations and symbols

&	And
Δ	Change in
=	Equals
>	Greater than
<	Less than
×	Multiplied by
%	Percentage
±	Plus-minus sign
AUD	Australian dollars
cm	Centimetres
DMGT	Differentiated Model of Giftedness and Talent
e.g.	For example
ES	Effect size
F	F statistic
FIFA	Fédération Internationale de Football Association
h	Hour(s)
ICC	Intraclass correlation coefficient
i.e.	That is
KTK	Körperkoordinationstest für Kinder
MANOVA	Multivariate analysis of variance
m	Metres
m^2	Metres squared
n	Number
NSW	New South Wales

p	P value
η_p^2	Partial eta squared effect size
RM-MANOVA	Repeated measure multivariate analysis of variance
s	Seconds
SD	Standard deviation
UEFA	Union of European Football Associations
USD	United States dollars
vs.	Versus
y	Year(s)

Abstract

Association football (soccer) is one of the most popular sports discussed in talent identification and development research. However, discrepancies exist in how researchers, coaches, and sporting professionals (i.e. scouts, recruiters, and skill acquisition specialists) define optimal practice. These discrepancies arise from several gaps in the current research. First, the different talent identification and development demands of established (e.g. Belgium, Germany, and England) and emerging (e.g. Australia, Iceland, and Panama) football nations are overlooked. Notably, nations competing for the same international success can vary in the size and depth of their talent pool, availability of financial and logistical resources for youth development, and the accessibility of systematic training environments. With a strong focus in most research placed on established football nations and limited evidence supporting the effectiveness of their approaches to talent identification, future research is needed to understand the implications of mirroring such practice in emerging football nations. Second, there is a lack of task representative assessments that measure soccer-specific and perceptual-cognitive skills. Consequently, coaches and sporting professionals' recruitment decisions are primarily based off their subjective opinions of a player's future playing potential, which biological maturation and relative age effects inherently confound. Finally, it is suggested that confounders that are difficult to operationalise with single output measures (e.g. sporting participation history) may have a significant impact on talent identification.

The present thesis aimed to address these issues through a series of five studies. Study one was a narrative review that analysed the current trends in talent identification and development research. Selection biases were apparent in established football nations,

with high-level development programs favouring players who were either more biologically mature, relatively older, or possessed early performance superiorities. Due to a lack of data on the benefits of the current approaches to talent identification, it was difficult to evaluate whether emerging football nations should simply adopt a similar approach to established football nations or develop their own. As a result, study one highlighted a framework that could assist emerging football nations. The three key areas that emerging football nations should focus on were: (1) preventing active deselection and dropout to maximise the size of the talent pool, (2) mitigating confounding factors, and (3) longitudinally tracking players' developmental trajectories. These strategies will likely help to reduce the talent identification demand and improve the depth of the talent pool.

Study two examined the use of small-sided games as a soccer-specific skills assessment for talent identification. Seventy-three high and low-level male youth soccer players (age = 13.3 ± 1.2 y) completed small-sided games (playing numbers = 4 vs. 4 and field dimensions = 30 × 20 m) under two conditions (condition 1 = 5 bouts of 3 min and condition 2 = 3 bouts of 5 min). Skill proficiency was measured using retrospective video analysis and recorded as the total number of completed involvements relative to the amount attempted. Small-sided games successfully discriminated playing levels ($F = 3.19$, $p < 0.01$, $\eta_p^2 = 0.98$), with high-level players displaying significantly greater passing and controlling the ball proficiency, when compared with low-level players. The high-level players also had a greater total skill proficiency than their low-level counterparts ($F = 21.51$, $p < 0.01$, $\eta_p^2 = 0.29$). These results show that small-sided games provided a task representative measure of soccer-specific skills and are a useful inclusion in talent identification assessments. However, there practical significance still warrants further investigation.

Study three investigated the construct and discriminant validity of a practical video-based decision-making assessment for talent identification. Three-hundred and twenty-eight soccer players (age = 13.0 ± 2.1 y) and 59 youth athletes (age = 14.3 ± 1.2 y) from three developmental stages (late childhood, early adolescence, and mid-adolescence) completed a video-based decision-making assessment. Players were shown 30 attacking situations (2 vs. 1 = 4, 3 vs. 1 = 9, 3 vs. 2 = 6, 4 vs. 3 = 5, and 5 vs. 3 = 6) and were instructed to select the interactive response (i.e. dribble, pass, or shoot) that would directly lead to a goal scoring opportunity. Response accuracy and time were recorded for all situations. The video-based decision-making assessment showed some construct validity, with faster response times in early and mid-adolescent soccer players when compared with the late childhood group ($F = 4.05$, $p < 0.01$, $\eta_p^2 = 0.03$). Overall, there was a decline in decision-making performance (i.e. decrease in response accuracy and increase in response time) when the situations contained more participating players ($F = 26.16$, $p < 0.01$, $\eta_p^2 = 0.43$). The video-based decision-making assessment lacked discriminant validity for talent identification, as there were minimal differences between academies for response accuracy and response time. Only response accuracy was able to discriminate youth academy soccer players from the control group to some extent (early adolescence: $F = 5.28$, $p < 0.001$, $\eta_p^2 = 0.09$ and mid-adolescence: $F = 8.14$, $p < 0.01$, $\eta_p^2 = 0.16$). It is suggested that coaches and sporting professionals apply caution when interpreting data from practical, video-based decision-making assessments. There is currently limited evidence supporting the effectiveness of these assessments for talent identification.

Study four detailed preliminary evidence for the influence of youth soccer players' sporting participation history on their performance characteristics. One hundred and four youth soccer players (age = 13.8 ± 1.2 y) completed anthropometry (stature, sitting height, and body mass), motor competence (balancing backwards, moving sideways, and jumping sideways), and physical fitness assessments (lower body muscular power, linear speed, change of direction skill, and intermittent aerobic endurance), along with a participation history questionnaire (start age in competitive soccer, total volume of soccer-specific practice, total volume of peer-led play, number of other sports, and total hours in other sports). An association was identified for superior motor competence and an earlier start age in competitive soccer ($F = 4.17$, $p = 0.01$, $\eta_p^2 = 0.11$), a higher total volume of soccer-specific practice ($F = 3.31$, $p = 0.02$, $\eta_p^2 = 0.09$), and a higher total volume of peer-led play ($F = 3.76$, $p = 0.01$, $\eta_p^2 = 0.10$). Whereas, superior physical fitness was related to less participation in other sports ($F = 2.50$, $p = 0.04$, $\eta_p^2 = 0.17$). Study four provides preliminary evidence for the inclusion of sporting participation history as a confounder in the talent identification and development process. Specifically, coaches and sporting professionals who use motor competence and physical fitness measures to inform selection decisions should consider the implications of different developmental pathways.

Study five examined the performance characteristics that discriminate academy status in youth Australian soccer. Seventy-four early and mid-adolescent academy soccer players (age = 13.0 ± 0.6 and 15.0 ± 0.6 y, respectively) completed multifactorial assessments of anthropometry, motor competence, physical fitness, decision-making (study three's assessment), and psychological traits (Task and Ego Orientation in Sport questionnaire). A stepwise discriminant analysis successfully classified early and mid-adolescent soccer players into their academies with an accuracy of 76.9 and 85.2%, respectively. The key indicators of a higher academy status in early adolescence were body mass, dynamic balancing ability, linear sprint speed, and change of direction skill. Whereas, in mid-adolescence the key indicators of a higher academy status were dynamic balancing ability, linear sprint speed, 3 vs. 1 response accuracy, and 3 vs. 1 response time. Study five's findings indicate a potential selection bias in the Australian youth soccer talent pool. Players in the high-level academy were grouped according to superior physical fitness measures. Whereas, players outside the high-level academy display slightly better decision-making skills in 3 vs. 1 situations. To maximise the size and the depth of the talent pool in Australia, coaches and sporting professionals should minimise any potential playing level differences that are of a physical nature.

Overall, the current thesis used Australia as a practical example of an emerging nation to create strategies that can assist with talent identification and development. It is recommended that small-sided games are included in multifactorial assessment batteries to provide a task representative measure of soccer-specific skills. However, practical perceptual-cognitive assessments that utilise a non-specific response action are advised against, as the data is not representative of the perceptual-cognitive skills required for soccer expertise. Coaches and sporting professionals should include longitudinal measures of sporting participation history alongside traditional confounders such as biological maturation and relative age effects. Adopting this approach will assist with reducing playing level differences that are based purely on physical prowess and encourage a shift towards selecting players who are gifted in other performance domains (e.g. soccer-specific skills and perceptual-cognitive skills).

Keywords: expertise; football; motor competence; perceptual-cognitive skills; physical fitness; psychological traits; soccer-specific skills; sporting participation history; team sports; youth.

Chapter one:

Introduction

Statement of the problem

Association football (soccer) is a popular team invasion sport where many promising youngsters pursue their aspirations of becoming elite performers. Expertise within dynamic, time-constrained sports like soccer is multifactorial, with individual-dependent interactions between the environment and the imposed task demands influencing performance (Simonton, 1999). Accordingly, soccer expertise is difficult to objectively quantify, as players can present with different performance characteristics (e.g. physical fitness, soccer-specific skills, and perceptual-cognitive skills) and solve the same functional movement problem (e.g. creating a goal scoring opportunity) in unique ways. Notwithstanding the difficulties with measuring soccer expertise, a significant focus in both research and practice is placed on understanding talent. It is believed that youth soccer players who eventually become professionals will show advanced performance characteristics that are identifiable at some stage during their development (Vaeyens, Lenoir, Williams, & Philippaerts, 2008; Williams & Reilly, 2000).

This notion has driven a plethora of research in the field of talent identification and development, with researchers, coaches, and sporting professionals (i.e. scouts, recruiters, and skill acquisition specialists) alike seeking to determine whether these performance characteristics are in fact indicative of future playing potential. Irrespective of whether there is a relationship between youth soccer players' performance characteristics during development and their future playing potential, their use in talent identification remains heavily favoured. As a result, several issues surround the current practical implementation of many approaches to talent identification. The first issue is that there is not a high level of evidence from more established football nations (e.g. Belgium, Germany, and England) that supports the effectiveness of talent identification to assist with developing expertise. For example, many high-level youth academies exhibit a relatively high annual turnover of players (~ 25%), indicating that those who are initially selected are likely not be those with the greatest future playing potential (Güllich, 2014). This is concerning as these nations are usually highly successful in international competition and are often role models for emerging nations. Without empirical support for how talent identification contributes to recruiting players who will eventually develop expertise, it is difficult to design strategies to assist emerging football nations (e.g. Australia, Iceland, and Panama) going forward. This is a crucial area that future research should address, as emerging football nations contain a relatively smaller talent pool, have lower soccer participation rates, less financial and logistical resources, and a weaker domestic competition. All these factors could potentially impact on the effectiveness of talent identification within these nations.

Another issue in talent identification practice is the continuing bias towards players with advanced anthropometry and superior physical fitness. One possible explanation for the continuing bias is that there is a lack of valid soccer-specific and perceptual-cognitive skills assessments that can assist coaches and sporting professionals when selecting suitable players for development programs. Many of the employed soccer-specific skills assessments are unable to replicate real competition demands as they are performed in closed environments with limited decision-making components. (Coelho-e-Silva et al., 2010; Figueiredo, Gonçalves, Coelho-e-Silva, & Malina, 2009a; Reilly, Williams, Nevill, & Franks, 2000). In addition, current decision-making methodologies are impractical and have limited applicability in multifactorial assessment batteries (Vaeyens, Lenoir, Williams, Mazyn, & Philippaerts, 2007a; Vaeyens, Lenoir, Williams, & Philippaerts, 2007b; Vänttinen, Blomqvist, & Häkkinen, 2010). Consequently, coaches and sporting professionals must primarily rely on their subjective judgement of a player's soccer-specific and perceptual-cognitive skills, which cognitive biases undoubtedly confound (Furley & Memmert, 2016).

The final issue with current practice is failing to account for the impact of different developmental approaches on talent identification. Much of the debate in talent development is whether a youth soccer player should specialise from an early age to focus specifically on accumulating a large volume of soccer-specific practice (Ericsson, Krampe, & Tesch-Römer, 1993), or diversify their learning experiences through sampling multiple other sports and engaging in informal play activities (Côté, Horton, MacDonald, & Wilkes, 2009a; Ford, Ward, Hodges, & Williams, 2009). Simply advocating one approach over another is problematic as a multitude of factors influence the development of expertise (Ackerman, 2014). From a talent identification perspective, both developmental approaches impose different demands. The early specialisation approach requires assessments that provide accurate and valid data of a player's future playing potential. However, many talent identification assessments are inaccurate as they are completed several years from adult performance (Vaeyens et al., 2008) and do not account for the effects of biological maturation (Malina, Rogol, Cumming, Coelho-e-Silva, & Figueiredo, 2015). Conversely, the early diversification approach reduces the demand on talent identification assessments as they are completed when players are older. Therefore, future research should investigate if different developmental approaches impact on the talent identification process.

Study objectives

The current thesis aimed to address some of the gaps in talent identification and development research and practice. The initial study focused on analysing established football nations' talent identification and development practice and discussed some of the potential limitations of applying them in emerging football nations. Furthermore, this study provided practical strategies that can assist emerging football nations to increase the size of their talent pool and reduce the impact of confounders. The following two studies were methodological and examined the validity of two practical soccer-assessments of soccer-specific and decision-making skills. The fourth study examined the influence of different developmental pathways on youth soccer players' performance in generic and specific talent identification assessments. The final study analysed the multifactorial nature of youth soccer players' performance characteristics to establish if differences were evident between two talent pools. This study used Australia as a practical example of an emerging football nation to expand the knowledge surrounding current talent identification practice.

Study one: Creating a framework for talent identification and development in emerging football nations (Chapter three)

Aim: Study one aimed to critically reflect on the existing talent identification and development research from an emerging football nation's perspective.

Significance: Study one was the first narrative review to discuss the differences between established and emerging football nations and how this can impact on their talent identification and development requirements. While many reviews are conducted in the area (Gledhill, Harwood, & Forsdyke, 2017; Sarmento, Anguera, Pereira, & Araújo, 2018), most do not provide actual strategies that will benefit governing bodies and sporting organisations – especially those who have a different infrastructure, soccer participation rates, and logistical and financial resources. This study proposed both a framework and practical recommendations that can guide emerging football nations' talent identification and development research and practice.

Study two: The use of small-sided games to assess skill proficiency in youth soccer players: A talent identification tool (Chapter four)

Aim: Study two aimed to investigate the use of small-sided games to measure skill proficiency in youth soccer players and determine whether the information gained from such assessments are applicable to talent identification.

Hypotheses: It was hypothesised that high-level players would display a significantly higher skill proficiency when compared with players belonging to a lower level youth academy. Also, it was hypothesised that the length of each small-sided games would not influence skill proficiency.

Significance: Study two provided support for the use of small-sided games in talent identification (Fenner, Iga, & Unnithan, 2016; Unnithan, White, Georgiou, Iga, & Drust, 2012). Small-sided games were a task representative measure of soccer-specific skills as players competed in an open performance environment that linked the sequential execution of multiple skills with decision-making processes. Small-sided games were both externally and ecologically valid as skill proficiency was independent of bout duration. Using study two's methodological design, it is possible to measures 16 players' skill proficiency in a 30-minute period. As such, small-sided games are both a valid and practical soccer-specific skills assessment that coaches and sporting professionals can implement in a talent identification setting.

Study three: Assessing the validity of a video-based decision-making assessment for talent identification in youth soccer (Chapter five)

Aim: Study three aimed to comprehensively evaluate the use of mobile technology as an alternative method of delivering video-based decision-making assessments in youth soccer and the implications of this for talent identification.

Hypotheses: It was hypothesised that older players with a greater number of years playing soccer would have superior decision-making performance (i.e. a high response accuracy and a faster response time). It was also hypothesised that as the stimulus-response choices increased (i.e. a higher number of participating players), decision-making performance would decrease (i.e. a lower response accuracy and a slower response time). Finally, it was hypothesised that high-level academy players would display better decision-making performances than players from a low-level academy and a control group.

Significance: The findings from study three are in contrast to previous studies that support the use of video-based decision-making assessments in talent identification (Keller, Raynor, Iredale, & Bruce, 2018b; O'Connor, Larkin, & Williams, 2016). It was demonstrated that despite mobile technology increasing the practicality of the video-based decision-making assessment, it lacked the sensitivity to discriminate players according to their academy status. It seems that the removal of key contextual information and the execution of soccer-specific skills confounds expertise-related differences in decision-making performance and limits the assessment to a general measure of perceptual-cognitive skills.

Study four: The confounding influences of sporting participation history on talent identification assessments in youth soccer (Chapter six)

Aim: Study four aimed to investigate the influence of Australian youth academy soccer players' sporting participation history on generic and sport-specific talent identification assessments.

Hypotheses: It was hypothesised that players who sample multiple sports and accumulate more peer-led play would display superior motor competence. It was also hypothesised that players who engage in fewer sports and accumulate more hours of soccer-specific practice would show superior physical fitness.

Significance: Study four was the first to demonstrate preliminary evidence for the confounding influence of sporting participation history on youth soccer players' performance in generic and sport-specific talent identification assessments. Sporting organisations need to develop a central repository to concurrently track players' weekly, monthly, and yearly hours of soccer-specific practice and peer-led play, along with their hours spent in other sports. When making selection decisions, coaches and sporting professionals can combine these measures with other confounders such as biological maturation and relative age effects.

Study five: A multifactorial analysis of Australian youth soccer players' performance characteristics (Chapter seven)

Aim: Study five aimed to investigate the performance characteristics that discriminate two age groups of Australian youth soccer players based on their academy status.

Hypotheses: It was hypothesised that players from a higher academy status would display superiorities in their anthropometry, physical fitness, and motor competence. It was also expected that these players would possess a high task orientation. Despite, study three demonstrating video-based decision-making assessments to have limited use in talent identification, previous research has supported their contribution to multifactorial models of performance in both individual (Novak, Bennett, Fransen, & Dascombe, 2018a, 2018b) and team sports (Woods, Raynor, Bruce, McDonald, & Robertson, 2016b). Therefore, it was hypothesised that players from a higher academy status would display superior decision-making performance.

Significance: Study five provided further insight into the current talent identification practices used within youth soccer in Australia. Significant differences between playing levels were evident, with players from a higher academy status possessing superiorities in motor competence and physical fitness. Notably, there was an indication that players from a lower academy status possessed superior decision-making skills. These playing level differences are problematic for the depth of the talent pool as they can reduce the likelihood of players who develop outside of high-level academy programs receiving any opportunities for later identification or selection (i.e. side entry). Study five's findings support the formation of initiatives like Football Federation Australia's 'Talent Support Program' to assist with minimising playing level differences and to allow players outside high-level academies to receive access to high-quality coaching support and appropriate developmental environments.

Chapter two:

Review of literature

Current perspectives on talent identification and development in soccer

Introduction

For many years, researchers, coaches, and sporting professionals have sought to determine the most effective approach to unearth new talent; players like Cristiano Ronaldo and Lionel Messi, who stun viewers worldwide with their dazzling speed, finesse, and footwork. The notion behind these 'naturally' talented players is somewhat perplexing and remains difficult to substantiate. Many researchers have aimed to understand the properties of talent, with the definitions dependent on the underlying theoretical model (Baker, Schorer, & Wattie, 2017). While most of these definitions and theoretical models are developed in other expertise domains such as education and music, it is important to understand how they apply in the context of sport. For example, Howe, Davidson, and Sloboda (1988) assigned five properties to talent: (1) it originates from genetically transmitted structures and is partly innate, (2) a trained individual can identify some advanced indicators from an early age, (3) these early indicators form the basis for predicting who is likely to excel, (4) only a minority are talented, and (5) talent is relatively domain-specific. Whereas, Ziegler, Ziegler, and Stoeger (2012) simply denoted talent as any individual with a high chance of achieving future excellence.

While the definitions of talent vary, many professional soccer clubs have their own youth academies to streamline financial and logistical resources into a small group of players who are assigned with the greatest future playing potential. These 'elite' academies are built on the premise that coaches and sporting professionals can identify talented players from an early age and that prolonged exposure to systematic training and development is required in the pursuit of excellence. However, their efficacy is largely questioned for several reasons. First, coaches and sporting professionals' recruitment decisions are usually based on inherently biased subjective opinions (Furley & Memmert, 2016) or confounded physical performance data (Helsen, Starkes, & Van Winckel, 1998; Johnson, Farooq, & Whiteley, 2017). Second, it is often a requisite that selected players pay a substantial annual fee to maintain their position within the development program (e.g. Australian youth soccer academy registration fees range from $1000 to $2500 per year), which creates unequal opportunities for players from a low socioeconomic background. Finally, evidence suggests that elite youth academies exhibit a high annual turnover of players (Güllich, 2014), meaning that those who are recruited earlier do not necessarily have a greater chance of future success than players who are recruited later. Consequently, it is imperative that the current state of practice is comprehensively evaluated to determine future directions for talent identification and development research.

Therefore, the purpose of this narrative review is to critically discuss talent identification and development research in soccer. The review describes the talent identification and development process in both research and practice. In addition, the review recognises the measures commonly used in talent identification research in soccer to quantify future playing potential (i.e. anthropometry, physical fitness, motor competence, soccer-specific skills, perceptual-cognitive skills, and psychological traits) and details their strengths and limitations. Finally, the review evaluates the impact of confounding factors such as biological maturation, relative age effects, and sporting participation history.

Talent pathways

The talent identification and development process explains several interacting stages that promising athletes are expected to experience in their pursuit of sporting excellence. Williams and Reilly (2000) initially proposed four distinct stages: talent detection, talent identification, talent selection, and talent development. Talent detection involves identifying youth athletes from a general sample who possess certain performance characteristics and/or abilities that are well matched to the imposed competitive demands of a sport (Figure 2.1a). Talent identification focuses on athletes currently involved in a sport, where coaches and sporting professionals identify those with the potential to develop future sporting excellence. Talent selection is ongoing and usually entails selecting athletes who meet the performance levels required for a squad or team. Finally, talent development is a complex process that involves providing promising athletes with a supportive learning environment that stimulates the development of their performance characteristics and/or abilities. Vaeyens et al. (2008) further extended the talent identification and development process to include a confirmation stage, where promising athletes are provided with the training demands of elite sporting competition to confirm their talented status (Figure 2.1b).

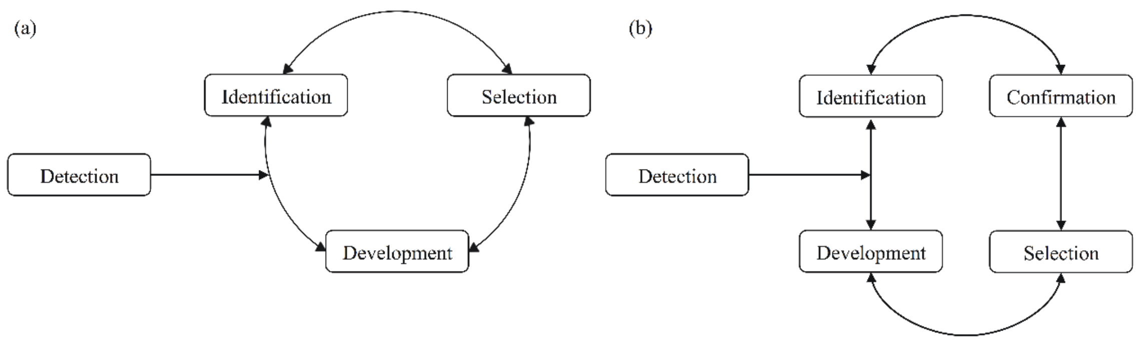

Figure 2.1. (a) Williams and Reilly (2000)'s talent identification and development process (b) Vaeyens et al. (2008)'s extended talent identification and development process.

In practice, the above models of the talent identification and development process form what is commonly termed the talent pathway. The talent pathway is unique as it is separate from traditional participation pathways and provides targeted support to promising youth athletes with the goal of developing sporting excellence. On face value, talent pathways differ between nations, but most entail the progression from an entry level skill acquisition program to selection into either a league-based team or national squad. An example from Football Federation Australia's (FFA) talent pathway shows the multi-stage process from skill acquisition to adult performance. Initially, talented players are identified from 11-years and recruited into academy and/or school-based programs (Figure 2.2a). Those players who display a high-level of performance within these programs are eligible for selection into National Youth Championship or National Training Centre Challenge squads. The final stage of talent identification coincides with the youth-to-senior transition, where players who show favourable performance characteristics are identified and selected into the national youth league teams. Additional selection opportunities in the Australian Joeys and Young Socceroos are also available to players who display exceptional performances (Figure 2.2b).

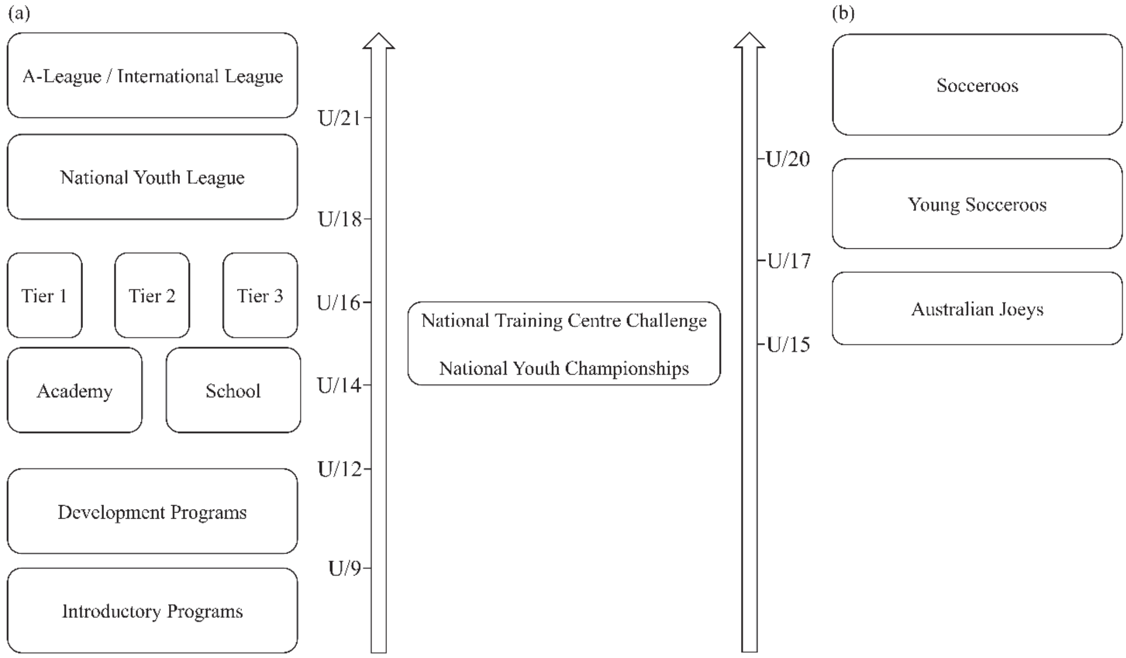

Figure 2.2. (a) Football Federation Australia's national competition talent pathway. (b) the opportunities available for exceptionally skilled players who show promise to contribute to the Australian national team (Football Federation Australia, 2015).

A key factor that underlies talent identification and selection decisions is the assessment of future playing potential. Future playing potential in soccer is rather difficult to conceptualise/quantify as it relates to dynamic, multifactorial characteristics that encompass both internal (e.g. motor skill performance, perceptual-cognitive skills, and psychological traits) and external (e.g. practice opportunities, financial and logistical resources, and social support) variables (Côté, 1999; Rossing, Stentoft, Flattum, Côté, & Karbing, 2018; Vaeyens et al., 2008). The Differentiated Model of Giftedness and Talent

(DMGT) is commonly used as a framework for talent identification in sport as it describes the process of talent development (Gagné, 1985, 2004, 2013). The DMGT associates potential with untrained natural abilities or gifts that serve as early indicators of future talent. However, both environmental and intrapersonal catalysts – which can exhibit positive or negative effects – influence the talent development process (Figure 2.3). Evidentially, the primary implications of the DMGT in the context of youth soccer is that players with higher early abilities should exhibit accelerated performance improvements and reach their talented status earlier than those players who are less gifted. Therefore, understanding these early abilities is of interest to coaches and sporting professionals working in talent identification and development.

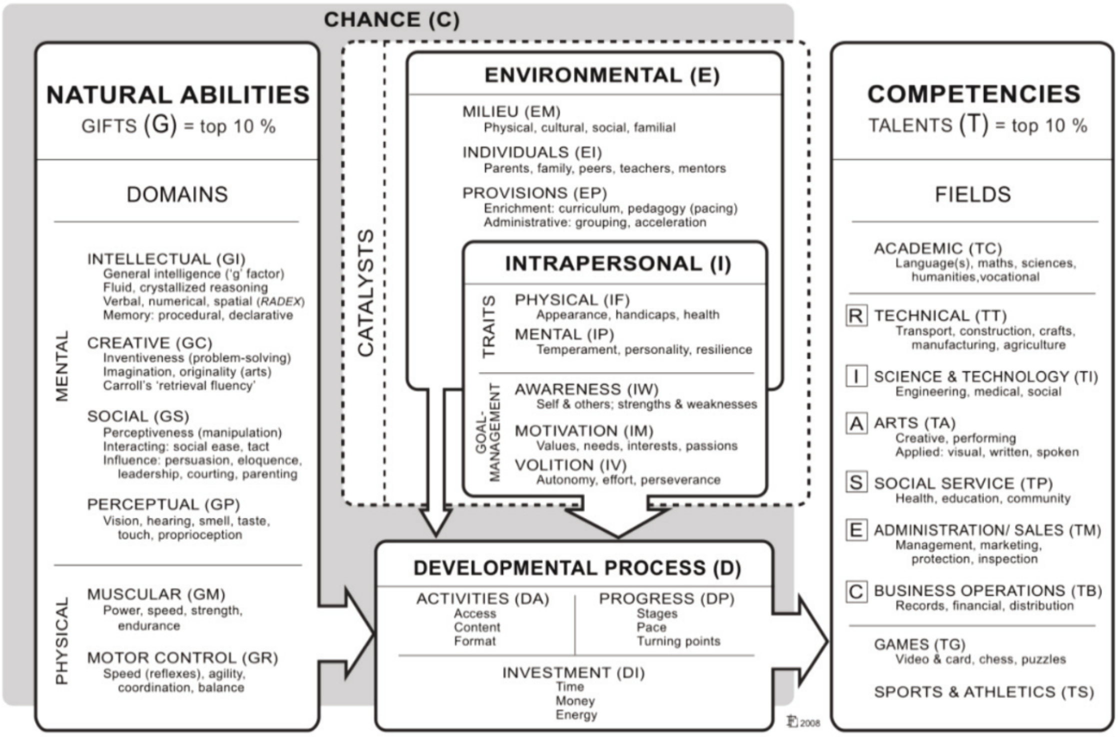

Figure 2.3. The Differentiated Model of Giftedness and Talent 2.0 (Gagné, 2013).

Identifying future playing potential in soccer

The effectiveness of a talent identification program is often judged on the ability of coaches and sporting professionals to identify youth players with the greatest potential for future success. Currently, there are two methods used to quantify future playing potential in soccer. The first method involves scouts or recruiters subjectively rating the key attributes (e.g. physical fitness, soccer-specific skills, and decision-making) of a player and determining the importance of these attributes for future success. Although scouts and recruiters recognise the multifactorial nature of soccer talent and stress the significance of soccer-specific skills, decision-making skills, and psychological traits (Larkin & O'Connor, 2017), they often mistake precursors of talent for early performance superiorities in anthropometry and physical fitness (Cripps, Hopper, & Joyce, 2016; Furley & Memmert, 2016). The second method of quantifying future playing potential is through an objective multifactorial analysis of a player’s performance characteristics. Williams and Reilly (2000) suggested the early indicators of future playing potential were either of a physical, physiological, psychological, or sociological nature (Figure 2.4). Since this seminal research, numerous studies have sought to determine whether players’ performance characteristics vary according to playing level (i.e. cross-sectional analyses) or whether current professional senior players possessed any superiorities in their performance characteristics during development (i.e. retrospective and longitudinal analyses).

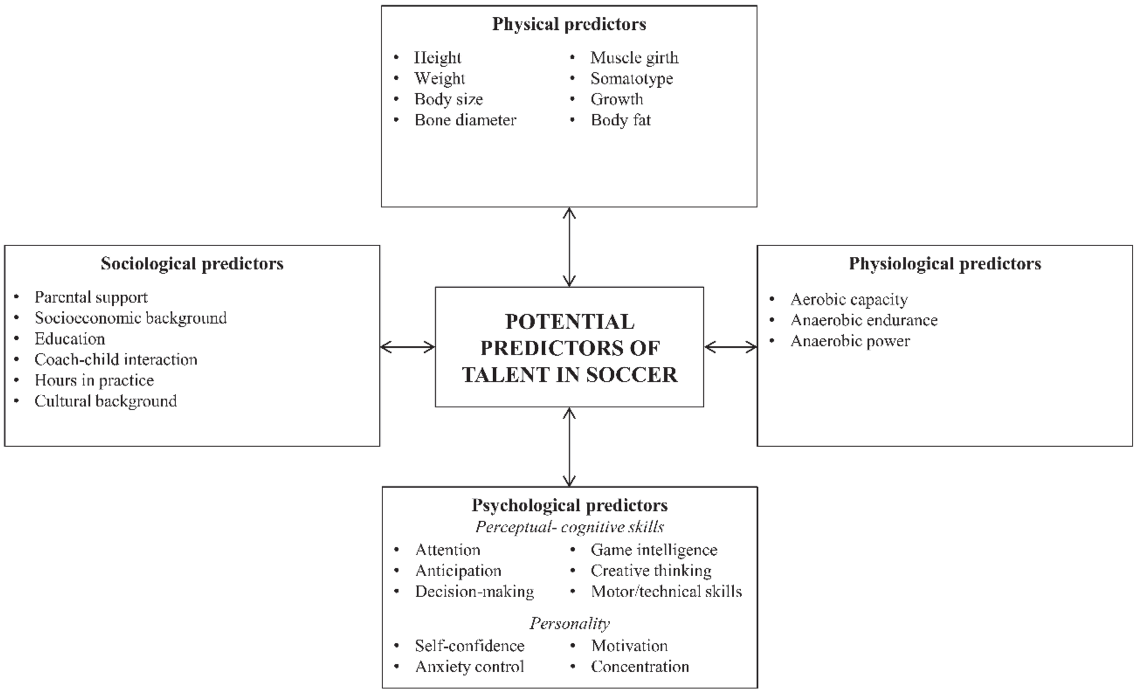

Figure 2.4. The potential predictors of talent in soccer from each sports science discipline (Williams & Reilly, 2000).

Anthropometry

The anthropometry of youth soccer players is well documented, with numerous studies reporting cross-sectional advancements in favour of players competing at higher levels (Table 2.1). Generally, high-level players are taller and heavier than those who either dropout (Deprez et al., 2015a; Figueiredo et al., 2009a), are not selected for a development program (Gil, Ruiz, Irazusta, Gil, & Irazusta, 2007; Gil et al., 2014b), or are competing at lower levels of competition (Coelho-e-Silva et al., 2010; Figueiredo et al., 2009a; Keller, Raynor, Bruce, & Iredale, 2018a; Vaeyens et al., 2006; Vandendriessche et al., 2012). Notably, playing level differences in anthropometry are evident from late childhood and span across most of development. However, it is acknowledged that during late childhood, high-level players are usually lighter than low-level players (Deprez, Fransen, Lenoir, Philippaerts, & Vaeyens, 2015b; Gil et al., 2014b) and that playing level differences are negatable once the sample becomes more homogenous during late adolescence (Huijgen, Elferink-Gemser, Lemmink, & Visscher, 2014; Lovell, Bocking, Fransen, & Coutts, 2018; Reilly et al., 2000).

Based on the available cross-sectional data, it is difficult to ascertain whether gifted youth soccer players possess advanced anthropometry, as a selection bias is apparent in high-level development programs (Johnson et al., 2017). This is concerning as retrospective analysis on longitudinal study designs have not yielded any clear conclusions that associate advanced anthropometry during development with players who attain soccer excellence (Table 2.2). While current professional senior players were taller and heavier during early and mid-adolescence, these findings are not consistent across studies and vary depending on players' nationality (Carling, Le Gall, & Malina, 2012; Deprez et al., 2015b; Emmonds, Till, Jones, Mellis, & Pears, 2016; Höner, Leyhr, & Kelava, 2017; Le Gall, Carling, Williams, & Reilly, 2010). Despite this, advanced anthropometry remains a favourable characteristic in talent identification and selection, regardless of the limited evidence suggesting its contribution to future soccer excellence.

Table 2.1. A cross-sectional analysis of the playing level differences in youth soccer players' anthropometry.

Study	Sample	Playing level	Measures	Results
Coelho-e-Silva et al. (2010)	Portuguese (*n* = 128) U/14	Elite Local	Stature, body mass, & skinfold thickness	Elite > local Stature & body mass
Deprez et al. (2015b)	Belgian (*n* = 388) U/10 – U/17	Club Dropout	Stature, sitting height, body mass, & body fat	Elite > dropout U/14: Body mass U/15: Stature & body mass U/17: Sitting height Dropout > elite U/10: Body mass
Figueiredo et al. (2009a)	Portuguese (*n* = 159) U/12 – U/15	Elite Club Dropout	Stature, sitting height, sitting height ratio, leg length, & skinfold thickness	Elite > club U/12 & U/13: Stature, sitting height, & body mass U/14 & U/15: Stature & sitting height Elite > dropout U/12 & U/13: Stature and sitting height U/14 & U/15: Stature, sitting height, & body mass
Gil et al. (2007)	Spanish (*n* = 194) U/15 – U/18	Selected Non-selected	Stature, body mass, body fat, body mass index, skinfold thickness, & limb circumferences	Selected > non-selected U/14: Stature Non-selected > selected U/14: Skinfold thickness
Gil et al. (2014b)	Spanish (*n* = 98) U/8 – U/9	Pre-selected Soccer camp Selected Non-selected	Stature, sitting height, leg length, body mass, body fat, limb fat, body mass index, & skinfold thickness	Soccer camp > pre-selected Body mass, body fat, limb fat & skinfold thickness No significant differences reported

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates advanced anthropometry values.

Table 2.1 (cont'd). A cross-sectional analysis of the playing level differences in youth soccer players' anthropometry.

Study	**Sample**	**Playing level**	**Measures**	**Results**
Huijgen et al. (2014)	Dutch (*n* = 113) U/17 – U/19	Selected Deselected	Stature, body mass, body fat, & lean body mass	No significant differences reported
Keller et al. (2018a)	Australian (*n* = 62) U/18	National elite State elite Sub-elite	Stature & body mass	<u>National elite > sub-elite</u> Stature
Lovell et al. (2018)	Australian (*n* = 214) U/13 – U/18	High Medium Low	Stature & body mass	No significant differences reported
Reilly et al. (2000)	English (*n* = 31) U/17	Elite Sub elite	Stature, body mass, body fat, & skinfold thickness	<u>Elite > sub-elite</u> Body fat <u>Sub-elite > elite</u> Stature
Vaeyens et al. (2006)	Belgian (*n* = 232) U/13 – U/15	Elite Sub-elite Non-elite	Stature, body mass, & skinfold thickness	<u>Non-elite> sub-elite & elite</u> U/15: Skinfold thickness
Vandendriessche et al. (2012)	Belgian (*n* = 78) U/16 – U/17	Nationals Futures	Stature, body mass, body fat, & body mass index	<u>Nationals > futures</u> U/16: Stature & body mass U/17: Stature, body mass, & body fat

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates advanced anthropometry values.

Table 2.2. A retrospective analysis of the playing level differences in youth soccer players' anthropometry.

Study	Sample	Playing level	Measures	Results
Carling et al. (2012)	French (n = 158) U/14	Professional Non-professional	Stature, body mass, & body fat	Professionals > non-professionals U/14: Stature
Deprez et al. (2015b)	Belgian (n = 72) U/15 – U/19	Contract No-contract	Stature, body mass, & body fat	No significant differences reported
Emmonds et al. (2016)	English (n = 433) U/12 – U/18	Professional Academy	Stature & body mass	No significant differences reported
Höner et al. (2017)	German (n = 14,178) U/12	Professional Semi-professional Non-professional	Stature & body mass	Professional > semi-professional > non-professionals Stature & body mass
Le Gall et al. (2010)	French (n = 115) U/14 – U/16	Internationals Professionals Amateurs	Stature, body mass, & body fat	Professionals > amateurs Body mass U/16: Stature

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates advanced anthropometry values.

Physical fitness

Youth soccer players' physical fitness also receives considerable attention in talent identification and development research (Table 2.3). Components of physical fitness – including intermittent aerobic endurance, change of direction skill, flexibility, linear sprint speed, and muscular endurance, power, and strength – commonly discriminate high from low-level players (Coelho-e-Silva et al., 2010; Deprez et al., 2015b; Figueiredo et al., 2009a; Gil et al., 2007; Gil et al., 2014b; Huijgen et al., 2014; Keller et al., 2018a; Lovell et al., 2018; Reilly et al., 2000; Vaeyens et al., 2006). These differences become apparent in late childhood and continue through to late adolescence. Like anthropometry, a selection bias is clear within the data and the talent pool seems oversaturated with players who possess superior physical fitness. However, the contribution of physical fitness to attaining future soccer excellence is slightly more convincing (Table 2.4). Several retrospective analyses of professional senior players identified superior aerobic endurance, linear sprint speed, and muscular power during mid and late adolescence as important discriminating characteristics (Deprez et al., 2015b; Emmonds et al., 2016; Gonaus & Müller, 2012; Höner et al., 2017; Le Gall et al., 2010). Nevertheless, the relatively low overall explained variance (Deprez et al., 2015b; Höner et al., 2017) highlights that other performance characteristics such as soccer-specific skill, perceptual-cognitive skill, and psychological traits also play a key role in identifying future playing potential (Vaeyens et al., 2008).

Table 2.3. A cross-sectional analysis of the playing level differences in youth soccer players' physical fitness.

Study	Sample	Playing level	Measures	Results
Coelho-e-Silva et al. (2010)	Portuguese (*n* = 128) U/14	Elite Local	Muscular power, linear sprint speed, repeated sprint ability, change of direction skill, & intermittent aerobic endurance	Elite > local Linear sprint speed & repeated sprint ability
Deprez et al. (2015b)	Belgian (*n* = 388) U/10 – U/17	Club Dropout	Muscular power, linear sprint speed, & intermittent aerobic endurance	Club > dropout U/10: Linear sprint speed U/14: Muscular power & linear sprint speed U/15: Muscular power & linear sprint speed
Figueiredo et al. (2009a)	Portuguese (*n* = 159) (U/12 – U/15)	Elite Club Dropout	Muscular power, linear sprint speed, change of direction skill, & anaerobic power	Elite > club U/12 & U/13: Muscular power & intermittent aerobic endurance U/14 & U/15: Change of direction skill & intermittent aerobic endurance Elite > dropout All squads: Muscular power, linear sprint speed, change of direction skill & intermittent aerobic endurance
Gil et al. (2007)	Spanish (*n* = 194) U/15 – U/18	Selected Non-selected	Muscular power, linear sprint speed, & aerobic capacity	Selected > non-selected U/15: Linear sprint speed & aerobic capacity U/16 & U/17: Linear sprint speed
Gil et al. (2014b)	Spanish (*n* = 98) U/8 – U/9	Pre-selected Soccer camp Selected Non-selected	Muscular power, muscular strength, linear sprint speed, change of direction skill, & intermittent aerobic endurance	Pre-selected > soccer camp Muscular power, linear sprint speed, change of direction skill, & intermittent aerobic endurance Selected > non-selected Change of direction skill & intermittent aerobic endurance

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates superior physical fitness.

Table 2.3 (cont'd). A cross-sectional analysis of the playing level differences in youth soccer players' physical fitness.

Study	Sample	Playing level	Measures	Results
Huijgen et al. (2014)	Dutch (*n* = 113) U/17 – U/19	Selected Deselected	Linear sprint speed, repeated sprint ability, change of direction skill, & intermittent aerobic endurance	Selected > de-selected Linear sprint speed & repeated sprint ability
Keller et al. (2018a)	Australian (*n* = 62) U/18	National elite State elite Sub-elite	Muscular power, linear sprint speed, change of direction skill, & intermittent aerobic endurance	National elite > state elite > sub-elite Intermittent aerobic endurance National elite > sub-elite Linear sprint speed
Lovell et al. (2018)	Australian (*n* = 214) U/13 – U/18	High Medium Low	Flexibility, muscular power, linear sprint speed, change of direction skill, & intermittent aerobic endurance	High > Medium Change of direction skill High > low Linear sprint speed & intermittent aerobic endurance
Reilly et al. (2000)	English (*n* = 31) U/17	Elite Sub elite	Muscular power, linear sprint speed, repeated sprint ability, change of direction skill, & aerobic capacity	Elite > sub-elite Muscular power, linear sprint speed, repeated sprint ability, change of direction skill, & intermittent aerobic endurance

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates superior physical fitness.

Table 2.3 (cont'd). A cross-sectional analysis of the playing level differences in youth soccer players' physical fitness.

Study	Sample	Playing level	Measures	Results
Vaeyens et al. (2006)	Belgian (*n* = 232) U/13 – U/15	Elite Sub elite Non-elite	Flexibility, muscular power, muscular strength, muscular endurance, linear sprint speed, change of direction skill, & intermittent aerobic endurance	<u>Elite > sub-elite</u> U/15: Flexibility, muscular endurance, & intermittent aerobic endurance U/16: Intermittent aerobic endurance <u>Elite > non-elite</u> U/13: Muscular power, muscular strength, muscular endurance, linear sprint speed, change of direction skill, & intermittent aerobic endurance U/14: Muscular power, muscular strength, linear sprint speed & intermittent aerobic endurance U/15: Flexibility, muscular power, muscular strength, muscular endurance, linear sprint speed, change of direction skill, & intermittent aerobic endurance U/16: Flexibility, muscular strength, muscular endurance, & intermittent aerobic endurance <u>Sub-elite > non-elite</u> U/13: Linear sprint speed U/14: Muscular strength, linear sprint speed, & intermittent aerobic endurance U/15: Muscular power, muscular strength, muscular endurance, & linear sprint speed
Vandendriessche et al. (2012)	Belgian (*n* = 78) U/16 – U/17	Nationals Futures	Flexibility, muscular power, muscular strength, linear sprint speed, & change of direction skill	Nationals > Futures U/16: Muscular power, muscular strength, linear sprint speed, and change of direction skill U/17: Flexibility, muscular power, muscular strength, & linear sprint speed

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates superior physical fitness.

Table 2.4. A retrospective analysis of the playing level differences in youth soccer players' physical fitness.

Study	Sample	Playing level	Measures	Results
Carling et al. (2012)	French (*n* = 158) U/14	Professional Non-professional	Muscular power, muscular strength, anaerobic power, & intermittent aerobic endurance	No significant differences reported
Deprez et al. (2015b)	Belgian (*n* = 72) U/15 – U/19	Contract No-contract	Muscular power, linear sprint speed, & intermittent aerobic endurance	<u>Contract > no-contract</u> Muscular power & linear sprint speed
Emmonds et al. (2016)	English (*n* = 433) U/12 – U/18	Professional Academy	Linear sprint speed & intermittent aerobic endurance	<u>Professional > academy</u> U/16: Linear sprint speed U/18: Linear sprint speed & intermittent aerobic endurance
Gonaus and Müller (2012)	Austrian (*n* = 1,642) U/15 – U/18	Drafted Non-drafted	Flexibility, muscular power, linear sprint speed, change of direction skill, & intermittent aerobic endurance	<u>Drafted > non-draft</u> U/15, U/16, & U/17: Muscular power, linear sprint speed, change of direction skill, & intermittent aerobic endurance U/18: Muscular power, linear sprint speed, & change of direction skill
Höner et al. (2017)	German (*n* = 14,178) U/12	Professional Semi-professional Non-professional	Linear sprint speed & change of direction skill	<u>Professional & semi-professional > non-professional</u> Linear sprint speed & change of direction skill <u>Professional > semi-professional</u> Linear sprint speed
Le Gall et al. (2010)	French (*n* = 115) U/14 – U/16	Internationals Professionals Amateurs	Muscular power, muscular strength, linear sprint speed, anaerobic power, & intermittent aerobic endurance	<u>Internationals > amateur</u> Linear sprint speed, muscular power, & anaerobic power U/16: Anaerobic power <u>Professionals > amateur</u> Anaerobic power

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates superior physical fitness.

Motor competence

In talent identification research, motor competence receives noticeably less attention, when compared with anthropometry and physical fitness (Table 2.5). In the context of youth sport, motor competence is a player's ability to execute a wide range of motor actions (Haga, 2009; Hands, 2008). Motor competence is sensitive to change during the early years of development in soccer players, with the greatest variations observed prior to the age of 12 (Fransen et al., 2017). Unlike other measures such as anthropometry and physical fitness, biological maturation has minimal effects on motor competence (Vandendriessche et al., 2012). It is also proposed as a preliminary measure of future skill potential (Vandorpe et al., 2011). The inclusion of motor competence in multifactorial talent identification assessment batteries is increasingly prevalent, with the Körperkoordinationstest für Kinder (KTK) usually used to collect data due to its practicality (Deprez et al., 2015b; Lovell et al., 2018; Vandendriessche et al., 2012).

While only a relatively small number of studies use motor competence to discriminate playing levels in youth soccer, the findings appear promising. The trend that high-level youth soccer players possess greater motor competence when compared with those competing at lower levels (Deprez et al., 2015a; Lovell et al., 2018) is also evident in other sports such as gymnastics (Vandorpe et al., 2011) and volleyball (Pion et al., 2015). However, motor competence is unable to explain the variance between current senior professional and non-professional soccer players (Deprez et al., 2015b), which is likely the result of the homogeneity that exists in older high-level performers. Future research should further examine the applicability of motor competence within talent identification and development through investigating its association with the development of soccer-specific skill.

Table 2.5. A cross-sectional analysis of the playing level differences in youth soccer players' motor competence.

Study	Sample	Playing level	Measures	Results
Deprez et al. (2015b)	Belgian (*n* = 388) U/10 – U/17	Club Dropout	Balancing backwards, moving sideways, & jumping sideways	<u>Club > dropout</u> U/10 & U/12: Jumping sideways & moving sideways U/11: Moving sideways U/13 and U/16: Jumping sideways
Lovell et al. (2018)	Australian (*n* = 214) U/13 – U/18	High Medium Low	Motor quotient	<u>High > medium > low</u> Motor quotient
Vandendriessche et al. (2012)	Belgian (*n* = 78) U/16 – U/17	Nationals Futures	Balancing backwards, moving sideways, & jumping sideways	No significant differences reported

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates superior motor competence.

Soccer-specific skills

Soccer-specific skills are an important performance characteristic in talent identification and development. Cross-sectional comparisons of playing levels (Table 2.6) indicate that high-level players outperform their low-level counterparts on assessments of ball control (Coelho-e-Silva et al., 2010; Figueiredo et al., 2009a; Keller, Raynor, Bruce, & Iredale, 2016), dribbling (Deprez et al., 2015b; Figueiredo et al., 2009a; Huijgen et al., 2014; Lovell et al., 2018; Reilly et al., 2000; Vaeyens et al., 2006), juggling (Vaeyens et al., 2006), lobbing (Vaeyens et al., 2006), passing (Figueiredo et al., 2009a; Keller et al., 2016), and shooting (Keller et al., 2016; Vaeyens et al., 2006). Playing level differences are also evident in retrospective analyses (Table 2.7), with current professional players showing better soccer-specific skills during adolescence when compared with non-professionals (Höner et al., 2017; Huijgen, Elferink-Gemser, Post, & Visscher, 2009).

A significant issue with talent identification research is the lack of methodological designs that are representative of real competition demands (Travassos, Duarte, Vilar, Davids, & Araújo, 2012c). Most studies isolate the motor component of a soccer-specific skill in a closed environment without integrating perceptual-cognitive processes. While more open assessments are available (Ali et al., 2007), they lack the construct validity to measure in-game performance (Serpiello, Cox, Oppici, Hopkins, & Varley, 2017). Small-sided games may account for the limitations of traditional assessments (Fenner et al., 2016; Unnithan et al., 2012) as they allow the reciprocal coupling of soccer-specific skills with decision-making processes in a representative competitive environment (Davids, Araújo, Correia, & Vilar, 2013). However, future research is needed to determine the optimal methodological design, as modifying the small-sided games constraints impose different skill demands (Abrantes, Nunes, Maçãs, Leite, & Sampaio, 2012; Almeida, Duarte, Volossovitch, & Ferreira, 2016; Christopher, Beato, & Hulton, 2016).

Table 2.6. A cross-sectional analysis of the playing level differences in youth soccer players' soccer-specific skills.

Study	Sample	Playing level	Measures	Results
Coelho-e-Silva et al. (2010)	Portuguese (*n* = 128) U/14	Elite Local	Ball control, dribbling, passing, & shooting	Elite > local Ball control
Deprez et al. (2015b)	388 Belgian (*n* = 388) U/10 – U/17	Club Dropout	Dribbling	Club > dropout U/10 & U/12: Dribbling
Figueiredo et al. (2009a)	Portuguese (*n* = 159) U/12 – U/15	Elite Club Dropout	Ball control, dribbling, passing, & shooting	Elite > club U/12 & U/13: Dribbling U/14 & U/15: Passing Elite > dropout U/12 & U/13: Ball control & dribbling U/14 & U/15: Ball control, dribbling, & passing Club > dropout U/14 & U/15: Passing Dropout > club U/14 & U/15: Dribbling
Huijgen et al. (2014)	Dutch (*n* = 133) U/17 – U/19	Selected Deselected	Dribbling	Selected > de-selected Dribbling
Keller et al. (2016)	Australian (*n* = 62) U/18	National elite State elite Sub-elite	Ball control, passing, & shooting	National elite > state elite Ball control & passing National elite > sub-elite Ball control, passing, & shooting State elite > sub-elite Passing

Notes: Only statistically significant differences ($p < 0.05$) are reported. Studies were only included if they employed an objective assessment of soccer-specific skills. > indicates superior soccer-specific skills.

Table 2.6 (cont'd). A cross-sectional analysis of the playing level differences in youth soccer players' soccer-specific skills.

Study	Sample	Playing level	Measures	Results
Lovell et al. (2018)	Australian (*n* = 214) U/13 – U/18	High Medium Low	Dribbling	<u>High and medium > low</u> Dribbling <u>High > medium</u> Dribbling
Reilly et al. (2000)	English (*n* = 31) U/17	Elite Sub elite	Dribbling & shooting	<u>Elite > sub-elite</u> Dribbling
Vaeyens et al. (2006)	Belgian (*n* = 232) U/13 – U/15	Elite Sub elite Non-elite	Dribbling, juggling, lobbing, & shooting	<u>Elite > non-elite</u> U/13 & U/14: Dribbling, juggling, & lobbing U/15: Dribbling, juggling, lobbing, & shooting U/16: Dribbling <u>Sub-elite > non-elite</u> U/13: Lobbing U/14 & U/15: Dribbling, juggling, & lobbing
Vandendriessche et al. (2012)	Belgian (*n* = 78) U/16 – U/17	Nationals Futures	Dribbling	No significant differences reported

Notes: Only statistically significant differences ($p < 0.05$) are reported. Studies were only included if they employed an objective assessment of soccer-specific skills. > indicates superior soccer-specific skills.

Table 2.7. A retrospective analysis of the playing level differences in youth soccer players' soccer-specific skills.

Study	Sample	Playing level	Measures	Results
Deprez et al. (2015b)	Belgian (*n* = 72) U/15 – U/19	Contracted No-contract	Dribbling	-
Huijgen et al. (2009)	Dutch (*n* = 131) U/14 – U/18	Professional Amateur	Dribbling	Professional > amateur Dribbling
Höner et al. (2017)	German (*n* = 14,178) U/12	Professional Semi-professional Non-professional	Ball control, dribbling, & shooting	Professional and semi-professional > non-professional Ball control, dribbling, & shooting Professional > semi-professional Shooting

Notes: Only statistically significant differences ($p < 0.05$) are reported. Studies were only included if they employed an objective assessment of soccer-specific skills. > indicates superior soccer-specific skills.

Perceptual-cognitive skills

Perceptual-cognitive skills (e.g. anticipation, pattern recognition, and game intelligence) and decision-making are integral aspects of successful performance in competitive match-play (Araújo, Davids, & Hristovski, 2006; Mann, Williams, Ward, & Janelle, 2007; Williams, 2000). However, there are limited task representative methodologies that fully capture the complexity of perceptual-cognitive skills and decision-making during soccer match-play. Cross-sectional analyses of youth players have attempted to identify playing level differences in both perceptual-cognitive skills (Table 2.8) and decision-making (Table 2.9). High-level players are better at anticipating the actions of their opponents (Reilly et al., 2000; Verburgh, Scherder, van Lange, & Oosterlaan, 2014), have higher cognitive functioning (Huijgen et al., 2015), are better at reading the game (Den Hartigh, Van Der Steen, Hakvoort, Frencken, & Lemmink, 2017), and have more efficient visual search behaviours when compared with their lower level counterparts (Vaeyens et al., 2007a; Vaeyens et al., 2007b). Furthermore, high-level players make more favourable decisions and are faster at responding to simulated match situations than low-level players (Keller et al., 2018b; O'Connor et al., 2016; Vaeyens et al., 2007a; Vaeyens et al., 2007b).

Although these studies provide a valuable insight into youth soccer players' perceptual-cognitive skills and decision-making, applying such methodologies in talent identification is not straightforward for several reasons. First, many of the assessments are completed in laboratory settings and require the use of large projection screens, pressure sensors, eye tracking technology, and verbal reports. Second, the employed assessments of cognitive function are domain-general and likely cannot capture soccer-specific expertise. Third, there is limited data on many of the decision-making assessments' construct validity, which makes it difficult to determine whether the assessment is measuring decision-making performance or some other construct (e.g. playing experience or declarative knowledge about the game). Finally, there is conjecture around the use of video-based assessments to measure perceptual-cognitive skill and decision-making as many factors compromise the task representativeness (e.g. third-person viewing perspective, execution of a non-specific response action, or limited contextual information). Due to these limitations, there is a lack of longitudinal and retrospective data that incorporates a measure of success with perceptual-cognitive skills or decision-making. Therefore, future research should aim to develop a practical, task representative perceptual-cognitive skill/decision-making assessment for talent identification and determine the contribution of such measures to attaining future success.

Table 2.8. A cross-sectional analysis of the playing level differences in youth soccer players' perceptual-cognitive skills.

Study	Sample	Playing level	Measures	Results
Den Hartigh et al. (2017)	Dutch ($n = 88$) U/11	Selected Non-selected	Game reading	Selected > non-selected Game reading: use more representation to describe game elements (greater complexity)
Huijgen et al. (2015)	Dutch ($n = 88$) U/14 – U/18	Elite Sub-elite	Creativity, cognitive-flexibility, metacognition, motor inhibition, planning, & working memory	Elite > non-elite Cognitive-flexibility, metacognition, & motor inhibition
O'Connor et al. (2016)	Australian ($n = 127$) U/15	Selected Not-selected	Anticipation, pattern recognition, & situational probability	Selected > non-selected Combined perceptual-cognitive performance
Reilly et al. (2000)	English ($n = 31$) U/17	Elite Sub-elite	Anticipation	Elite > sub-elite Anticipation
Vaeyens et al. (2007a)	Belgian ($n = 87$) U/14 – U/16	Elite Sub-elite Regional Non-player	Fixation location, fixation order, & search rate	Elite > sub-elite, regional, & non-player Fixation location: less time on defensive players & more time on marked attackers Fixation order: higher search order
Vaeyens et al. (2007b)	Belgian ($n = 65$) U/15	Successful Less successful	Fixation location, fixation order, & search rate	Successful > less successful Fixation location: focused more on the player with the ball Fixation order: more fixations of shorter duration Search rate: more exhaustive search
Verburgh et al. (2014)	Dutch ($n = 126$) U/9 – U/13	Highly talented Amateur	Attention, intelligence, motor inhibition, & working memory	Highly talented > amateur Motor inhibition: less errors
	English ($n = 137$) U/9 – U/17	Elite Sub-elite	Anticipation, memory recall, peripheral awareness, situational probability, stereoscopic depth, and visual acuity	Elite > sub-elite Anticipation (1 vs. 1 & 11 vs. 11) U/9: Situation probability (key players) U/11: Peripheral awareness U/13: Peripheral awareness

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates superior perceptual-cognitive skills.

Table 2.9. A cross-sectional analysis of the playing level differences in youth soccer players' decision-making skills.

Study	Sample	Playing level	Measures	Results
Keller et al. (2018b)	Australian (*n* = 62) U/18	National elite State elite Sub-elite	Response accuracy	<u>National elite > state-elite > sub-elite</u> Response accuracy
O'Connor et al. (2016)	Australian (*n* = 127) U/15	Selected Not-selected	Response accuracy	<u>Selected > non-selected</u> Response accuracy
Vaeyens et al. (2007a)	Belgian (*n* = 87) U/14 – U/16	Elite Sub-elite Regional Non-player	Response accuracy & response time	<u>Elite > regional</u> Response accuracy: 5 vs. 3 Response time: 3 vs. 1, 3 vs. 2, 4 vs. 3, & 5 vs. 3 <u>Elite > non-player</u> Response accuracy: 3 vs. 1, 4 vs. 3, & 5 vs. 3 Response time: 2 vs. 1, 3 vs. 1, 3 vs. 1, 4 vs. 3, & 5 vs. 3 <u>Sub-elite > regional</u> Response time: 3 vs. 1, 3 vs. 2, & 5 vs. 3 <u>Sub-elite > non-player</u> Response accuracy: 3 vs. 1, 4 vs. 3, & 5 vs. 3 Response time: 2 vs. 1, 3 vs. 1, 3 vs. 1, 4 vs. 3, & 5 vs. 3
Vaeyens et al. (2007b)	Belgian (*n* = 65) U/15	Successful Less successful	Response accuracy & response time	<u>Successful > less successful</u> Response accuracy: 3 vs. 1, 3 vs. 2, 4 vs. 3, & 5 vs. 3 Response time: 2 vs. 1, 3 vs. 1, 3 vs. 1, 4 vs. 3, & 5 vs. 3

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates superior decision-making skills. vs. = versus.

Psychological traits

Talent identification methodologies are criticised for their inability to include assessments of psychological traits alongside measures of anthropometry, physical fitness, soccer-specific skills, and perceptual-cognitive skills (MacNamara & Collins, 2011). Psychological traits are imperative to quantifying future playing potential, as talented players must possess the capacity to interact with developmental opportunities afforded in the environment (Abbott & Collins, 2004). Based on the available data, high-level youth soccer players show psychological traits that are believed to facilitate their learning and overall development (Table 2.10). Specifically, these psychological traits include: an achievement motivation focused on success rather than failure (Zuber, Zibung, & Conzelmann, 2015), an achievement orientation towards goal setting (Zuber et al., 2015), a goal orientation that is intrinsic and task focused (Kavussanu, White, Jowett, & England, 2011; Reilly et al., 2000), and better self-regulation based on reflection and effort (Toering, Elferink-Gemser, Jordet, & Visscher, 2009). While differences are evident between high and low-level youth soccer players' psychological traits, the knowledge around their contribution to future soccer excellence is limited (Table 2.11). Currently, there is substantial debate around whether these psychological traits mediate or directly influence how expertise develops and whether their effects change over time (Gledhill et al., 2017; Höner & Feichtinger, 2016; Van Yperen, 2009). Consequently, future research should longitudinally track the psychological traits of talented youth soccer players and determine the relationship with not only developmental processes but with success itself.

Table 2.10. A cross-sectional analysis of the playing level differences in youth soccer players' psychological traits.

Study	Sample	Playing level	Measures	Results
Coelho-e-Silva et al. (2010)	Portuguese (*n* = 128) U/14	Elite Local	Goal orientation	Elite > local Goal orientation: ego
Figueiredo et al. (2009a)	Portuguese (*n* = 159) U/12 – U/15	Elite Club Dropout	Goal orientation	No significant differences reported
Huijgen et al. (2014)	Dutch (*n* = 113) U/17 – U/19	Selected Deselected	Anxiety control, concentration, goal orientation, motivation, mental preparation, team emphasis, & self-confidence	No significant differences reported
Reilly et al. (2000)	English (*n* = 31) U/17	Elite Sub-elite	Goal orientation	Elite > sub-elite Goal orientation: task
Toering et al. (2009)	Dutch (*n* = 444) U/12 – U/18	Elite Non-elite	Self-regulation	Elite > non-elite Self-regulation: reflection & effort
Kavussanu et al. (2011)	English (*n* = 118) U/13 – U/17	Elite Non-elite	Goal orientation & parental climate	Elite > non-elite Goal orientation: task Parental control: learning & enjoyment (mother) Parental control: effort (mother & father)
Zuber et al. (2015)	Swiss (*n* = 97) U/13 – U/15	Selected Not-selected	Achievement motivation, achievement orientation, & self-determination	Selected > not-selected Achievement motivation: hope for success Achievement orientation: goal & win Self-determination

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates perceived favourable psychological characteristics for success.

Table 2.11. A retrospective analysis of the playing level differences in youth soccer players' psychological traits.

Study	Sample	Playing level	Measures	Results
Höner and Feichtinger (2016)	German (*n* = 2,677) U/12 – U/16	Selected Non-selection	Achievement motivation, achievement orientation, competition anxiety, goal orientation, self-concept, self-efficacy, and volitional skills	<u>Selected > non-selected</u> Achievement motivation: greater hope for success & less fear of failure Achievement orientation: competition & goal Competition anxiety: less worry Goal orientation: task Self-concept & self-efficacy Volitional skills: self-optimised
Van Yperen (2009)	Dutch (*n* = 63) U/15 – U/18	Successful Unsuccessful	Coping, goal commitment, goal importance, perceived stressors, & social support	<u>Successful > unsuccessful</u> Goal commitment Coping strategies: problem-focused Social support: seek when needed

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates perceived favourable psychological characteristics for success.

Confounding factors and future playing potential

Although there are many performance characteristics that discriminate playing levels in youth soccer, it is often difficult for coaches and sporting professionals to determine whether these superiorities are indicative of future playing potential (Vaeyens et al., 2008). Numerous confounders are prevalent in talent identification and development, with some having a significant impact on an individual level (e.g. biological maturation and relative age effects) and others on a cultural/structural level (e.g. previous sporting participation). The timing and tempo of biological maturation can lead to significant inter-individual differences in the development of players' performance characteristics, especially those of a physical nature (Fransen et al., 2017; Morris et al., 2018; Philippaerts et al., 2006). Likewise, relative age effects – a bias towards players born early in a selection year – are known to exist from as early as six years and can have widespread effects on players' motor, psychological, and social development (Helsen et al., 1998). Finally, players' developmental activities and previous sporting participation is associated with their level of expertise (Ford et al., 2009; Ward, Hodges, Starkes, & Williams, 2007). Therefore, careful consideration is needed when analysing players' current performance characteristics to account for these confounders.

Biological maturation

The influence of biological maturation on talent identification and development is well documented (Table 2.12 and 2.13). More mature players in the same chronological age group possess superior anthropometry and physical fitness when compared to those who mature later (Carling et al., 2012; Figueiredo, Gonçalves, Coelho-e-Silva, & Malina, 2009b; Rommers et al., 2018). More mature players are also consistently overrepresented in elite talent development programs (Coelho-e-Silva et al., 2010; Figueiredo et al., 2009b; Johnson et al., 2017) and are perceived to possess greater long-term playing potential (Cripps et al., 2016; Furley & Memmert, 2016). Evidently, it appears that many elite talent development programs are quantifying early performance superiorities as opposed to future playing potential. As a result, less mature players whose performance characteristics develop at a slower rate, are often actively deselected or dropout from elite talent development programs (Deprez et al., 2015b), despite evidence suggesting they possess superior soccer-specific skills and psychological traits (Malina et al., 2005; Malina, Ribeiro, Aroso, & Cumming, 2007; Zuber, Zibung, & Conzelmann, 2016). The main implications of these selection biases in the talent pool is that less mature players will likely require exceptional soccer-specific skills, perceptual-cognitive skills, or psychological traits to survive the talent pathway. Therefore, it is imperative that coaches and sporting professionals understand the inter-individual differences in the timing and tempo of biological maturation and their impact on players' performance characteristics.

Table 2.12. The influence of biological maturation on youth soccer players' performance characteristics.

Study	Sample	Classification	Measures	Results
Carling et al. (2012)	French (*n* = 158) U/14	Early On-time Late	Stature, body mass, body fat, muscular power, muscular strength, linear sprint speed, anaerobic power, & intermittent aerobic endurance	<u>Early > on-time > late</u> Stature, body, muscular power, muscular strength, linear spear, & anaerobic power
Figueiredo et al. (2009b)	Portuguese (*n* = 159) U/12 – U/15	Early On-time Late	Stature, sitting height, sitting height ratio, leg length, body mass, skinfold thickness, muscular power, linear sprint speed, change of direction skill, intermittent aerobic endurance, ball control, dribbling, passing, shooting, & goal orientation	<u>Early > on-time > late</u> U/12 & U/13: Stature, body mass, & skinfold thickness U/14 and U/15: Stature, body mass, skinfold thickness, & muscular power <u>On-time > early & late</u> U/14 & U/15: Sitting height ratio <u>Late > early & on-time</u> U/12 & U/13: Anaerobic power
Malina et al. (2005)	Portuguese (*n* = 69) U/15	Pubic hair – stage 1 Pubic hair – stage 2 Pubic hair – stage 3 Pubic hair – stage 4 Pubic hair – stage 5	Ball control, dribbling, passing & shooting	<u>Pubic hair 2, 4 and 5 > pubic hair 1</u> Dribbling
Rommers et al. (2018)	Belgian (*n* = 619) U/10 – U/15	Early On-time Late	Stature, sitting height, body mass, balancing backwards, moving sideways, jumping sideways, dribbling, linear sprint speed, & change of direction skill	<u>Early > late</u> Linear sprint speed and change of direction skill <u>Late > early</u> Balancing backwards and jumping sideways

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates advanced performance characteristics.

Table 2.13. The influence of biological maturation on youth soccer players' selection status.

Study	**Sample**	**Playing level**	**Measures**	**Results**
Carling et al. (2012)	French (n = 158) U/14	Elite	Maturity status	Elite Early: 22% On-time: 62% Late: 16%
Coelho-e-Silva et al. (2010)	Portuguese (n = 128) U/14	Elite Local	Skeletal age	Elite > local Skeletal age
Deprez et al. (2015b)	Belgian (n = 388) U/10 – U/17	Club Dropout	Maturity offset	Club > dropout U/17: Maturity offset
Figueiredo et al. (2009a)	Portuguese (n = 159) U/12 – U/15	Elite Club Dropout	Skeletal age	Elite > club & dropout U/14 & U/15: Skeletal age Elite Early = 42 % On-time = 46% Late = 12% Club Early = 28 % On-time = 61% Late = 11% Dropout Early = 25 % On-time = 50% Late = 25%

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates advanced biological maturation.

Table 2.13 (cont'd). The influence of biological maturation on youth soccer players' selection status.

Study	Sample	Playing level	Measures	Results
Gil et al. (2014b)	Spanish (*n* = 98) U/8 – U/9	Pre-selected Soccer camp Selected Non-selected	Age at peak height velocity & maturity offset	No significant differences reported
Johnson et al. (2017)	English (*n* = 293) U/9 – U/16 Middle Eastern (*n* = 179) U/12 – U/17	Elite	Skeletal age	<u>Elite</u> U/12: Odds ratio = 2.2 U/13: Odds ratio = 2.4 U/14: Odds ratio = 3.5 U/15: Odds ratio = 4.9 U/16: Odds ratio = 10.4 U/17: Odds ratio = 20.0
Le Gall et al. (2010)	French (*n* = 115) U/14 – U/16	Internationals Professionals Amateurs	Maturity status & skeletal age	<u>Internationals > amateurs</u> U/15 & U/16: Maturity status
Malina et al. (2007)	Portuguese (*n* = 69) U/15	Highest skill High skill Middle skill Low skill Lowest skill	Sexual maturity	<u>Highest skill</u> Public hair 4 and 5: 85% <u>High skill</u> Public hair 4 and 5: 79%
Vandendriessche et al. (2012)	Belgian (*n* = 78) U/16 – U/17	Nationals Futures	Age at peak height velocity	<u>Nationals > Futures</u> U/16 & U/17: Age at peak height velocity

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates advanced biological maturation.

Relative age effects

Another confounding factor that significantly influences talent identification and development is the relative age differences between players competing in the same chronological age groupings (Table 2.14 and 2.15). These relative age differences can result in biases towards older players who display superior anthropometry and physical fitness when compared with their younger counterparts (Carling, Le Gall, Reilly, & Williams, 2009; Fragoso, Massuca, & Ferreira, 2015; Gil et al., 2014a; Hirose, 2009; Lovell et al., 2015). Notably, these older players are often favoured in elite talent development programs and youth national teams (Delmore, Boiché, & Raspaud, 2010; Finnegan, Richardson, Littlewood, & McArdle, 2017; González-Víllora, Pastor-Vicedo, & Cordente, 2015; Helsen et al., 1998; Helsen, Van Winckel, & Williams, 2005; Hirose, 2009; Jiménez & Pain, 2008; Johnson et al., 2017; Lovell et al., 2015; Mujika et al., 2009; Roman & Fuchslocher, 2013; Sæther, 2015; Skorski, Skorski, Faude, Hammes, & Meyer, 2016; van den Honert, 2012; Vincent & Glamser, 2006; Votteler & Höner, 2014) and in some cases have up to a 5 times greater chance of selection when compared with younger players (Roman & Fuchslocher, 2013).

The systematic bias towards older players creates several issues within the talent identification and development process. Importantly, relative age effects can exist where there are minimal inter-individual differences in biological maturation (Helsen et al., 1998). This is particularly relevant in youth soccer as relative age effects are only weakly associated with biological maturation, possibly due to younger players requiring advanced biological maturation to survive the demands of talent development (Towlson et al., 2017). Currently, there is evidence to suggest that it is indeed these younger players who have a greater chance of receiving a professional contract (Carling et al., 2012; McCarthy & Collins, 2014; McCarthy, Collins, & Court, 2016). Together, governing bodies, sporting organisations, and coaches should consider strategies to minimise relative age effects within their talent pool.

Table 2.14. The influence of the relative age effect on youth soccer players' performance characteristics.

Study	Sample	Classification	Measures	Results
Carling et al. (2009)	French (*n* = 160) U/14	Quartile 1 – 4	Skeletal age, stature, body mass, body fat, muscular power, muscular strength, linear sprint speed, anaerobic power, & intermittent aerobic endurance	Quartile 1, 2, & 3 > 4 Stature
Deprez et al. (2013)	Belgian (*n* = 374) U/11 – U/17	Quartile 1 – 4	Age at peak height velocity, stature, body mass, muscular power, & linear sprint speed	Quartile 2 & 3 > 4 U/15: Stature
Fragoso et al. (2015)	Portuguese (*n* = 133) U/15	Quartile 1 – 4	Stature, body mass, muscular power, linear sprint speed, & intermittent aerobic endurance	Quartile 1 > 2 Muscular power Quartile 1 > 3 Stature & body mass Quartile 1 & 2 > 4 Linear sprint speed Quartile 2 & 3 > 4 Stature
Gil et al. (2014a)	Spanish (*n* = 88) U/10 – U/11	Quartile 1 – 4	Age at peak height velocity, maturity offset, stature, sitting height, leg length, body mass, body mass index, skinfold thickness, muscular power, muscular strength, linear sprint speed, change of direction skill, & intermittent aerobic endurance	Quartile 1 > 4 Maturity offset, stature, sitting height, leg length, fat free mass, linear sprint speed, & change of direction skill

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates superior performance characteristics.

Table 2.14 (cont'd). The influence of the relative age effect on youth soccer players' performance characteristics.

Study	Sample	Classification	Measures	Results
Hirose (2009)	Japanese (*n* = 332) U/10 – U/15	Quartile 1 – 4	Skeletal age, stature, & body mass	Quartile 1 > 2 U/11: Body mass Quartile 1 > 3 U/12: Stature U/13: Stature & body mass Quartile 1 > 4 U/11 & U/14: Stature & body mass U/13: Stature Quartile 2 > 3 U/14: Stature Quartile 2 > 4 U/14: Stature & body mass Quartile 3 > 4 U/14: Stature & body mass
Lovell et al. (2015)	English (*n* = 1,212) U/10 – U/18)	Quartile 1 – 4	Age at peak height velocity, stature, body mass, muscular power, linear sprint speed, change of direction skill, & intermittent aerobic endurance	Quartile 1 > 3 U/12 & U/14: Stature and body mass Quartile 1 & 4 > 3 U/18: Muscular power Quartile 1 > 4 U/10: Intermittent aerobic endurance U/12 & U/14: Stature & body mass U/16: Stature Quartile 2 > 1 U/12: Stature and body mass Quartile 2 > 4 U/12 & U/14: Stature and body mass Quartile 3 & 4 > 1 U/10 & U/18: Age at peak height velocity Quartile 4 > 1 U/14: Change of direction skill

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates superior performance characteristics.

Table 2.14 (cont'd). The influence of the relative age effect on youth soccer players' performance characteristics.

Study	Sample	Classification	Measures	Results
Skorski et al. (2016)	German (n = 544) U/16 – U/21	Quartile 1 – 4	Stature, body mass, body fat, muscular power, linear sprint speed, & intermittent aerobic endurance	No significant differences reported
Votteler and Höner (2014)	German (n = 10,130) U/12 – U/15	Quartile 1 – 4	Stature, body mass, linear sprint speed, change of direction skill, ball control, dribbling, & shooting	<u>Quartile 4</u> Above normal stature and body mass development curve Accelerate development in overall performance characteristics

Notes: Only statistically significant differences ($p < 0.05$) are reported.

Table 2.15. The influence of the relative age effect on youth soccer players' selection status.

Study	Sample	Playing level	Results
Augste and Lames (2011)	German (*n* = 911) U/17	Elite	Stronger relative age effects More league points More goals scored Concede fewer goals
Carling et al. (2009)	French (*n* = 160) U/14	Professional Non-professional	Professional Quartile 1: 45.6% Quartile 4: 70.0%
Delmore et al. (2010)	French (*n* = 363,590) U/7 – U/18	Dropout	Dropout A higher percentage of dropouts were from quartile 3 & 4
Finnegan et al. (2017)	Irish (*n* = 1,936) U/14	Elite	Elite Quartile 1: 38.2% Quartile 4: 12.6%
González-Víllora et al. (2015)	European (*n* = 289) U/17 – U/19	National	National Quartile 1: 44.1% (U/17) & 36.8% (U/19) Quartile 4: 11.7% (U/17) & 18.8 % (U/19)
Helsen et al. (1998)	Belgian (*n* = 1,337) U/7 – U/17	National Elite Provincial	National Quartile 1: 46.3% Quartile 4: 10.0% Elite Relative age effects evident from 6 years of age Quartile 1: 35.7% Quartile 4: 13.6% Provincial A higher percentage of dropouts were from quartile 3 & 4
Helsen et al. (2005)	European (*n* = 2,175) U/12 – U/18	National Elite	National Quartile 1: 49.0% (U/16) & 29.9% (U/18) Quartile 4: 7.6% (U/16) & 18.1% (U/18) Elite Quartile 1: 32.6% (U/12 & U/14) Quartile 2: 16.0% (U/12 & U/14)

Notes: Only statistically significant differences ($p < 0.05$) are reported.

Table 2.15 (cont'd). The influence of the relative age effect on youth soccer players' selection status.

Study	Sample	Playing level	Results
Hirose (2009)	Japanese (*n* = 332) U/10 – U/15	Elite	Elite Quartile 1: 37.9 – 58.8% Quartile 4: 3.2 – 13.5%
Jiménez and Pain (2008)	Spanish (*n* = 2,053) U/9 – U/18	Elite	Elite Quartile 1: 45% Quartile 4: 10%
Johnson et al. (2017)	English (*n* = 293) U/9 – U/16 Middle Eastern (*n* = 179) U/12 – U/17	Elite	Elite High percentage of quartile 1 & 2 in U/9 to U/16 squads
Lovell et al. (2015)	English (*n* = 1,212) U/9 – U/18	Lower-league	Lower-league Quartile 1 & 4 odds ratio: 5.28 First semesters & second semester odds ratio: 2.72 Highest relative age effects between U/13 & U/16: 5.45 – 6.13
Mujika et al. (2009)	Spanish (*n* = 13,405) U/11 – U/18	Elite Regional School	Elite Quartile 1: 46.6 Quartile 4: 10.0% Odds ratio: 4.44 Regional Quartile 1: 28.6 Quartile 4: 21.1 Odds ratio: 1.30 School Quartile 1: 27.1% Quartile 2: 22.9% Odds ratio: 1.13

Notes: Only statistically significant differences ($p < 0.05$) are reported.

Table 2.15 (cont'd). The influence of the relative age effect on youth soccer players' selection status.

Study	Sample	Playing level	Results
Roman and Fuchslocher (2013)	Swiss (*n* = 50,581) U/11 – U/18	National Elite Club	National Quartile 1: 52.7% (U/15), 45.7% (U/16), 52.4% (U/17), & 42.6% (U/18) Quartile 9.8% (U/15), 11.7% (U/16), 13.1% (U/17), & 8.9% (U/18) Odds ratio: 4.97 (U/15), 3.61 (U/16), 3.74 (U/17), & 4.43 (U/18) Elite Quartile 1: 37.8% Quartile 4: 13.9% Odds ratio: 2.53 Club Quartile 1: 25.3% Quartile 4: 23.4%
Sæther (2015)	Norwegian (*n* = 92) U/15 – U/19	National	National 65 – 75% of re-selected players were born in first half of the year Quartile 1: 46% Quartile 4: 7%
Simmons and Paull (2001)	English (*n* = 9,074) U/15 – U/16	National Elite Elite school School	National Oldest: 50% Youngest: 36% Elite Oldest: 61% Youngest: 11% Elite school Oldest 75% Youngest: 6% School (1) Oldest: 72% (2) Youngest: 6%

Notes: Only statistically significant differences ($p < 0.05$) are reported.

Table 2.15 (cont'd). The influence of the relative age effect on youth soccer players' selection status.

Study	Sample	Playing level	Results
Skorski et al. (2016)	German (*n* = 554) U/16 – U/21	National	National Odds ratio of quartile 4 players becoming professional: 3.04 Quartile 1: 48.1% (U/16), 51.6% (U/17), 50.4% (U/18), 47.2% (U/19), 47.1% (U/20), & 47.3% (U/21) Quartile 4: 5.4% (U/16), 6.5% (U/17), 8.1% (U/18), 10.7% (U/19), 13.7% (U/20), & 12.2% (U/21)
van den Honert (2012)	Australian (*n* = 351) U/14 and U/20	Elite	Elite Quartile 1: 42.5% (U/14 & U/15) & 44.7% (U/17 & U/20) Quartile 4: 12.0% (U/14 & U/15) & 10.6% (U/17 & U/20) Odds ratio: 3.51 (U/14 & U/15) & 4.15 (U/17 & U/20)
Vincent and Glamser (2006)	American (*n* = 24) U/17	National	National Quartile 1: 54.2% Quartile 4: 16.7%
Votteler and Höner (2014)	German (*n* = 10,130) U/12 – U/15	Elite	Elite Odds ratio: 2.14 (U/12), 2.11 (U/13), 1.98 (U/14), & 2.31 (U/15)

Notes: Only statistically significant differences ($p < 0.05$) are reported.

Sporting participation history

Another prevalent confounding factor in the talent identification and development process is a player's sporting participation history. Several developmental pathways are associated with soccer expertise, with future playing potential viewed differently in each (Côté, 1999; Côté, Baker, & Abernethy, 2003, 2007; Côté & Fraser-Thomas, 2007). The early specialisation pathway involves participating in soccer from an early age and focuses on accumulating a high volume of goal-directed, soccer-specific practice with the main purpose to improve performance (Ericsson et al., 1993). The premise of future playing potential in the early specialisation pathway is performance-oriented and requires coaches and sporting professionals to identify superiorities. In contrast, the early diversification pathway involves sampling multiple sports during childhood with an emphasis on participating in various forms of peer-led play (Côté et al., 2003). Soccer specialisation occurs during adolescence, with future playing potential the product of greater learning adaptability, higher intrinsic motivation, and greater skill potential (Côté, Lidor, & Hackfort, 2009b).

Retrospective analyses of current professional players have provided coaches and sporting professionals with a greater understanding of the implications of both pathways on talent identification and development (Table 2.16). Although the pathways may differ depending on the professional player's nationality, some similarities are evident. Professional players begin participating in soccer through peer-led play (Ford et al., 2009; Hendry & Hodges, 2018; Hornig, Aust, & Güllich, 2016; Williams, Ward, Bell-Walker, & Ford, 2012) and are involved in multiple sports throughout development (Haugaasen, Toering, & Jordet, 2014; Hornig et al., 2016). Professional players seem to specialise in soccer later than non-professional players (Haugaasen et al., 2014; Hendry & Hodges, 2018; Hornig et al., 2016), but are still able to accumulate high volumes of soccer-specific practice (Ford et al., 2009; Hendry & Hodges, 2018; Roca, Williams, & Ford, 2012; Sieghartsleitner, Zuber, Zibung, & Conzelmann, 2018; Zibung & Conzelmann, 2013). Although these studies offer an insight into current professional players' sporting participation history, the overall findings are rather inconsistent and their impact on the attainment of expertise is difficult to ascertain. Usually, retrospective recall techniques (e.g. sporting participation questionnaires) are associated with bias, as data is collected several years following the completion of specific development activities/sports (Howard, 2011; Kemp, 1988). While some have implemented yearly questionnaires to negate this bias, single-use questionnaires are still widespread in practice. To overcome this limitation, future research should adopt concurrent tracking of players' sporting participation history along with determining whether specific activities benefit and/or detriment youth soccer players in the talent identification and development process.

Table 2.16. A retrospective analysis of soccer players sporting participation history.

Study	Sample	Playing level	Results
Ford et al. (2009)	English (*n* = 33)	Elite Released Recreational	<u>Elite > recreational</u> More hours of practice during the sampling years <u>Elite > released</u> More hours of peer-led play per year <u>Released > recreational</u> More hours of practice during the sampling years
Ford and Williams (2012)	English (*n* = 32)	Professional Non-professional	<u>Professional > non-professional</u> Earlier start age in soccer practice More hours of practice More hours per year in practice and play during adolescence
Haugaasen et al. (2014)	Norwegian (*n* = 735)	Professional Non-professional	<u>Professional > non-professional</u> Specialised exclusively in soccer later
Hendry and Hodges (2018)	Scottish (*n* = 102)	Senior professional Youth professional Academy	<u>Senior professional > youth professional & academy</u> No early specialisers <u>Senior professional > youth professional</u> More peer-led play <u>Senior & youth professional > academy</u> Starter earlier in the academy system More hours of practice during childhood

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates a perceived favourable sporting participation history.

Table 2.16 (cont'd). A retrospective analysis of soccer players sporting participation history.

Study	Sample	Playing level	Results
Hornig et al. (2016)	German (*n* = 102)	National Professional Amateur	National > Professional Debuted in professional competition earlier More practice in other sports during adolescence National > Amateur Earlier nomination for junior representative teams Specialised exclusively in soccer later Specialised after more years of involvement More peer-led play prior to age of 10 More practice in other sports during adolescence Professional > Amateur Earlier nomination for junior representative teams More peer-led play prior to age of 10 Greater increase in practice during adolescence & adulthood
Sieghartsleitner et al. (2018)	Swiss (*n* = 294)	National Regional Local	Youth national team selection • High peer-led play and average practice hours • High practice and average peer-led play hours
Williams et al. (2012)	English (*n* = 36)	High-performing Low-performing Non-elite	High-performing > low-performing & non-elite More hours of peer-led play
Zibung and Conzelmann (2013)	Swiss (*n* = 159)	National Top professional Professional Regional	Senior performance level Two early patterns: (1) above average hours in practice and player, & (2) above average hours in practice in more other sports sampling.

Notes: Only statistically significant differences ($p < 0.05$) are reported. > indicates a perceived favourable sporting participation history.

Conclusion

Overall, talent identification and development are essential stages of the talent pathway, with the goal to identify and develop players who demonstrate the greatest potential for future success (Vaeyens et al., 2008; Williams & Reilly, 2000). It is believed that this potential initially arises from gifts (Gagné, 1985, 2004, 2013), which are measurable from an early age (Howe et al., 1988). Quantifying playing level differences in soccer has yielded relatively consistent results, with players competing at a higher level being more likely to possess superiorities in their anthropometry (Coelho-e-Silva et al., 2010; Deprez et al., 2015b), physical fitness (Reilly et al., 2000; Vaeyens et al., 2006), soccer-specific skills (Figueiredo et al., 2009a; Keller et al., 2016), perceptual-cognitive skills (Den Hartigh et al., 2017; Vaeyens et al., 2007a), and psychological traits (Höner & Feichtinger, 2016; Zuber et al., 2015).

Although playing level differences are evident, it is important to acknowledge several issues with current practice. There is little evidence supporting the direct benefits of these superiorities during childhood and adolescence on future success. Furthermore, there are limited practical methodologies to assess soccer-specific and perceptual-cognitive skills that have sufficient construct and ecological validity for talent identification. Finally, inter-individual differences in the timing and tempo of biological maturation (Carling et al., 2012; Johnson et al., 2017), relative age (Mujika et al., 2009; Roman & Fuchslocher, 2013), and sporting participation history (Sieghartsleitner et al., 2018; Zibung & Conzelmann, 2013), confounds how coaches and sporting professionals perceive talent. Future research should focus on creating task representative soccer-specific and perceptual-cognitive skills assessments to assist with minimising selection biases within high-level development programs.

Chapter three:

Study one

Creating a framework for talent identification and development in emerging football nations

As per the peer-reviewed manuscript **Accepted and Published Online** in *Science and Medicine in Football*

Bennett, K.J.M, Vaeyens, R., and Fransen, J. (2018). Creating a framework for talent identification and development in emerging football nations. *Science and Medicine in Football*. doi: 10.1080/24733938.2018.1489141

"Study one provides are narrative review on the challenges emerging football nations face when identifying and developing talent".

Abstract

Talent identification and development in football is a complex, multifaceted process. Currently, most of the research in this domain is conducted in highly ranked, established football nations where the sport is immensely popular (e.g. Belgium, Germany, and England). While these nation's data are informative to some degree, there is little conclusive evidence supporting the effectiveness of traditional talent identification approaches. Typically, talent identification involves actively selecting promising players with early performance superiorities without considering the changes that can occur during development. Consequently, it is difficult to develop a framework for emerging football nations as the repercussions of adopting traditional approaches to talent identification are likely greater due to differences in the size of the talent pool, accessibility of systematic training environments, and availability of financial and logistical resources. It is proposed that emerging football nations should focus on: preventing active deselection and dropout to maximise the size of the talent pool, mitigating the influence of confounding factors on talent identification, and longitudinally tracking players throughout development to document the performance profiles that lead to football expertise. Collectively, these strategies can reduce the reliance on identifying players based on early performance superiorities and focus on holistic, long-term development.

Keywords: soccer, youth, expertise, giftedness

Introduction

Association football is the world's most popular team sport and is played by over 250 million athletes worldwide (Weil, Giulianotti, Joy, Alegi, & Rollin, 2017). The pinnacle of footballing success is the opportunity to contest the Fédération Internationale de Football Association (FIFA) World Cup, where 210 nations compete for 32 spots in the final group stage of the tournament. Unsurprisingly, winning the FIFA World Cup can bring considerable prestige and accolades (2018 FIFA World Cup received USD 38 million), which encourages governing bodies to identify and develop gifted youth players who show promise to eventually contribute to their nation's success. However, creating a talent pathway that streamlines promising players to a country's senior national team is undoubtedly confounded by many factors acting on both a global (e.g. population size, available talent pool, financial and logistical resources, strength of the domestic competition, and popularity of football compared to other team sports) and individual (e.g. coaching biases, inter-individual differences in the timing and onset of maturation, relative age effects, and location effects) level. These confounders create discrepancies in the practices used for talent identification and development, and in turn can lengthen the gap between the achievements of different nations competing for the same international success.

Based on the relative popularity of football and the international success of the national team, football nations are considered to exist on a continuum. Established football nations are highly successful at an international level and are characterised by a large talent pool, high football participation rates, considerable financial and logistical resources, and a strong domestic competition. Comparatively, emerging football nations are less successful at an international level and contain a smaller talent pool, lower football participation rates, less financial and logistical resources, and a weaker domestic competition. A practical example of the existing discrepancies between two countries on different sides of this continuum is observed through a direct comparison of the successes of Germany and Iceland; both nations who qualified for the 2018 FIFA World Cup. Germany, an established football nation ranked 1st and 2nd in the FIFA country rankings for their male and female teams, have won six FIFA World Cups, eleven Union of European Football Associations (UEFA) European Championships, one FIFA Confederations Cup, and one Olympic Gold Medal. Germany's football participation rates are high – 6.6 million players out of a total 83 million – and their domestic competition is strong, with players earning an average of €1.2 million per year (Sporting Intelligence, 2017). Competitive matches are watched by an average of 41,518 spectators. In contrast, the emerging football nation Iceland is significantly less successful on an international scale and is ranked 21st and 22nd for female and male teams, respectively. Their major achievements include qualifying four times for the finals of a major international tournament, and recently defeating England in the UEFA European Championships round of 16. Iceland's absolute participation rates are lower – 20,000 out of a possible 334,000 – and their domestic competition mainly consists of native players (77%) who earn an average of €30,000 (Fieldo, 2014). Approximately 1,200 spectators attend each stadium to watch competitive matches.

Despite the differences in many of these global confounders, the goal of all countries, irrespective of whether they are established or emerging, is to achieve international success. While many emerging football nations can compete on an international scale, they are often unable to consistently perform at this level for a prolonged period. As such, understanding established football nations' talent identification and development practices may provide a valuable insight into how emerging football nations can structure their talent pathway. However, the existing body of research seems to highlight the importance of talent identification and development practices for international success but does not provide adequate rationale of the underlying principles needed to create a successful program. Therefore, the following considerations are needed to understand if and how existing talent identification and development research derived from established football nations can be implemented in emerging football nations: (1) How does the definition of talent impact on the criteria used to identify and select promising players into high-level academies and development programs? (2) Can emerging football nations adopt established football nations' current talent identification and development practices? (3) Do emerging football nations require alternative approaches to guide the identification and development of talent? The aim of this study is to critically reflect on the existing talent identification and development research from an emerging football nation's perspective and propose a framework and practical recommendations that guide talent identification and development practice.

Football talent

Football-specific talent is a misunderstood notion that is difficult to conceptualise. Typically, football talent is interpreted relative to theoretical frameworks used as a foundation for talent identification and development research and practice (Vaeyens et al., 2008). One of the most popular frameworks in talent identification research and sports practice is the DMGT (Gagné, 1985, 2004, 2013). In the DMGT, talent – the exceptional mastery of domain-specific knowledge and skill – arises from innate, generic abilities or gifts that are identified from an early age and place the individual in the top 10 % of age- and experienced-matched peers. When applying the DMGT to football, a direct relationship between the existence of early abilities and how players attain domain-specific expertise is assumed. However, within complex, multifactorial sports like football, it is unknown whether early superiorities in one and/or every subdomain (e.g. physical fitness, technical skill, tactical understanding) are necessary to develop excellence. Therefore, explicitly defining football talent using a strict criterion like that in the DMGT is problematic, as a combination of abilities in different subdomains can produce the same performance outcome. Based on this notion, it is quite possible for a player with '*above average'* abilities across multiple subdomains to eventually reach a higher performance level as an adult than a player who possesses an exceptional ability in one subdomain – the *'above average'* hypothesis.

The DMGT also details that talent emerges following a continuous period of systematic training, termed talent development. According to this framework, intrapersonal and environmental catalysts influence talent development and make it difficult to determine an optimal design and standardised practice. While the underlying premise of this section of the DMGT can help to understand some of the processes involved in developing football expertise, there is little conclusive evidence detailing how these catalysts influence talent development. It is unknown whether intrapersonal catalysts such as psychosocial characteristics (e.g. goal motivation, self-regulation, and parent support) mediate or directly influence how expertise develops and whether their effects change over time (Höner & Feichtinger, 2016; Toering et al., 2009; Van Yperen, 2009; Zuber et al., 2015, 2016). Also, the specific contribution of each practice activity (e.g. deliberate practice and play) to the development of expertise is contentious (Macnamara, Moreau, & Hambrick, 2016). There are opposing opinions on whether gifted individuals require an extensive period of systematic training through deliberate practice (Ericsson et al., 1993; Ericsson & Pool, 2016; Ward et al., 2007) or if they can achieve the same level of expertise through sampling multiple sports and deliberate play (Côté et al., 2003, 2007; Côté et al., 2009b; Hornig et al., 2016; Soberlak & Côté, 2003). Finally, it is important to consider how governing bodies allocate financial and logistical resources to sporting organisations that provide the talent development process as this can limit the opportunities available to gifted players (e.g. number of academy positions, quality of training facilities, and number of support staff) and adds another level to the complex intrapersonal/environmental interaction.

It is evident that adopting a popular traditional theoretical framework like the DMGT in practice is limited by various underlying assumptions. While relaxing the assumptions will likely have smaller repercussions for established football nations (because their larger talent pool more flexibly negates the effects of potentially missing a promising youth player), they place undue stress on the systems emerging football nations employ. Therefore, it is important to detail talent identification and development practices in established football nations before understanding how these practices might need to be changed to meet the demands of emerging football nations.

Talent identification and development in established football nations

Talent identification and development in football is a multifaceted process, as successful performance results from the interaction between players' intrinsic dynamics and the ever changing environmental and task demands (Phillips, Davids, Renshaw, & Portus, 2010). Hence, football expertise results from the ability to continuously adapt functional movement solutions to changing task demands. As such, players possess their own unique blend of functional constraints, often termed performance characteristics in research (e.g. anthropometry, physical fitness, motor coordination, perceptual-cognitive skills, domain-specific skills, and psychosocial traits). Many researchers seek to identify` the performance characteristics that relate to football expertise through group-wise comparisons of playing standards (e.g. high vs. low-level), selection statuses (e.g. identified vs. non-identified), age groups, and playing positions (e.g. defenders, midfielders, and forwards). These studies predominantly focus on highly ranked, established football nations, where the sport is immensely popular with high youth participation numbers: Germany (Höner & Feichtinger, 2016; Höner et al., 2017; Höner

& Votteler, 2016; Höner, Votteler, Schmid, Schultz, & Roth, 2015), Portugal (Coelho-e-Silva et al., 2010; Figueiredo et al., 2009a), Belgium (Deprez et al., 2015a; Deprez et al., 2015b; Vaeyens et al., 2006; Vandendriessche et al., 2012), France (Carling et al., 2012; Le Gall et al., 2010), England (Emmonds et al., 2016; Reilly et al., 2000), and the Netherlands (Huijgen et al., 2014).

In established football nations, players perceived as talented are more biologically mature (Coelho-e-Silva et al., 2010; Figueiredo et al., 2009a; Johnson et al., 2017; Vandendriessche et al., 2012), born earlier in the selection year (Figueiredo et al., 2009a; Gil et al., 2014b; Johnson et al., 2017) and display advancements in anthropometry and superiorities in physical fitness (Coelho-e-Silva et al., 2010; Deprez et al., 2015b; Figueiredo et al., 2009a; Vaeyens et al., 2006), when compared with players who are deselected or drop out. While most of the key differences are of a physical nature, it is important to acknowledge the data from isolated analyses of youth players' perceptual-cognitive and domain-specific skills. High-level youth soccer players can better anticipate the actions of their opponents, more efficiently adapt their visual search strategies, and possess superior game reading, when compared to lower level players (Den Hartigh et al., 2017; Vaeyens et al., 2007a; Vaeyens et al., 2007b). In addition, these high-level players perform better on technique assessments of dribbling, passing, and shooting (Vaeyens et al., 2006). Although these data are informative, *a-priori* analyses of talent are problematic as they do not detail the dynamic nature of development or control for the confounding influences of maturation or relative age effects.

As a reaction to the limitations of cross-sectional research, a noteworthy shift towards longitudinal study designs that model players' developmental trajectories and allow for retrospective analyses of players who achieve successful adult performances is evident. Interestingly, players' performance characteristics only begin to differ during late adolescence, where the confounding effects of maturation appear to diminish, and the development of most performance characteristics have peaked (Fransen et al., 2017; Morris et al., 2018; Philippaerts et al., 2006). The available longitudinal evidence points towards professional senior players displaying superior linear sprint speed (Emmonds et al., 2016; Le Gall et al., 2010), explosive leg power (Deprez et al., 2015b; Le Gall et al., 2010), and intermittent aerobic endurance (Emmonds et al., 2016) during late adolescence when compared with less successful players. Furthermore, professional players appear to display better performances on closed technical assessments of dribbling, ball control and shooting when compared with non-professionals (Höner et al., 2017).

The largely physical nature of successful players' performance characteristics could be the result of two underlying issues. It is highly probable that researchers focus specifically on physical assessments as the testing methodologies are well established when compared with those used for technical and tactical skills. Also, selection processes likely bias the remaining sample of adolescent players in favour of older and/or, earlier maturing players. Specifically, younger and/or less mature players whose performance characteristics develop at a slower rate, are often actively deselected or dropout from talent development programs, which may be the result of coaches and sporting professionals perceiving them as less talented (Cripps et al., 2016; Furley & Memmert, 2016). This is concerning, as later maturing players are often technically and psychologically superior to their early maturing counterparts, yet are still not selected in national or regional talent squads (Zuber et al., 2016). Evidently, later maturing players require exceptional performances in some aspect of their development to just survive in the talent system, despite possessing a greater chance of becoming successful (Krogman, 1959). Therefore, to create a framework for emerging football nations, coaches and sporting professionals must carefully consider these confounding factors, as they significantly influence how players are identified and developed in established football nations. Furthermore, if the profound effects of these confounders are observed in established football nations – where the talent pool is large – their influence on emerging football nations might well be substantially greater.

Talent identification and development in emerging football nations

From the data collected in established football nations, there is limited conclusive evidence that supports the utility and effectiveness of current approaches to talent identification. Therefore, simply adopting traditional talent identification approaches in emerging football nations is considerably difficult as it can create several issues due to the differences in the size of the talent pool, accessibility of systematic training environments, and availability of financial and logistical resources. The first issue is the increased burden of missing a potentially talented player. Established football nations' early identification approach assumes that talent is a relatively stable capacity and that early superiorities in players' performance characteristics are a valid predictor of future potential (Baker, Schorer, & Wattie, 2017). However, in most instances, there is considerable variability in how these characteristics develop over time (Fransen et al., 2017; Morris et al., 2018; Philippaerts et al., 2006). Adopting less-than-perfect early identification practices increases the risk of missing talented players and can have profound consequences for the overall depth of the talent pool.

The second issue is coaches and sporting professionals assessing talent without accounting for confounding factors such as biological maturation and relative age effects. While coaches and sporting professionals are aware of the multifaceted nature of talent and acknowledge that technical, tactical, and psychological skills are important in the talent identification process (Christensen, 2009; Larkin & O'Connor, 2017), the tendency to favour older and/or earlier maturing players is persistent (Johnson et al., 2017). Subsequently, younger and/or late maturing players are deselected despite having the potential to supersede the performance of the older and/or more mature players (Zuber et al., 2016). With an already substantially smaller talent pool in emerging football nations, this bias would create greater homogeneity of players' performance profiles, which in turn could potentially reduce the overall depth of the talent pool. This has important repercussions when making selection decisions based on isolated assessments of players' current performance characteristics. It is imperative that coaches and sporting professionals identify and select talent with a consideration for the potential changes that can occur due to natural growth and development.

The final issue is determining a player's talent status purely using physical characteristics. It is well known that physical prowess influences players' selection into high-level academies and development programs (Coelho-e-Silva et al., 2010; Deprez et al., 2015b; Figueiredo et al., 2009a; Vaeyens et al., 2006). However, it is uncertain how these early physical superiorities contribute to players attaining future success. Although successful players present some physical superiorities during late adolescence (Deprez et al., 2015b; Emmonds et al., 2016; Le Gall et al., 2010), the implemented retrospective analysis alone cannot determine causality. Furthermore, football expertise is multifactorial and not idiosyncratic to a standard set of skills or abilities (Vaeyens et al., 2008). Players with less pronounced physical capacities will likely compensate by refining their technical and tactical skills, and once their physical capacities develop, have a broader performance profile than those who showed early superiorities. Therefore, it is imperative that alternative metrics are developed and assessed for talent identification and development in emerging football nations, which can help quantify the multifactorial nature of football talent. Granting it is possible to create representative tasks that measure perceptual-cognitive (Vänttinen et al., 2010) and domain-specific skills (study two), emerging football nations can use these assessments to minimise the reliance on identifying and developing players' who are predominantly physically gifted.

A practical framework

Despite the abundance of talent identification and development research, there is a clear need to re-evaluate how the knowledge and practice is transferred from established to emerging football nations. There is still limited information surrounding current talent identification and development practice in emerging football nations. As such, the first step is to establish a best-practice framework that guides coaches' and sporting professionals' talent status decisions. This framework should focus on three key areas: (1) increasing the size of the available talent pool, (2) mitigating confounding factors, and (3) tracking players' developmental trajectories.

Increasing the size of the talent pool

It is necessary for emerging football nations to ensure that the available talent pool is large enough to minimise any chances of missing future elite performers. To do so, emerging football nations' talent identification and development programs should reduce active deselection and dropout. The emerging football nation Iceland has reduced active deselection in their academy systems in an attempt to shift the focus towards holistic and inclusive development. This approach provides more players with greater accessibility to high-level coaching and appropriate development environments. Typically, there is a high-turnover of players in football academies. Early entry into football academies is often associated with an early exit (Güllich, 2014). One strategy that can help to reduce the high turnover of players is relaxing the selection criteria and focusing on players who display '*above average'* performance characteristics in several aspects related to football performance. In this sense, a greater emphasis is needed on combining physical assessments with perceptual-cognitive and domain-specific skill data.

Although preventing active deselection is important for emerging football nations, players dropping out of football completely is another major issue. Generally, high-level football academies promote early recruitment to allow players to receive a large volume of systematic training and coaching from an early age (Ford et al., 2012). Despite some evidence that has correlated early specialisation with increased short-term youth success (Emrich & Güllich, 2016; Güllich & Eike, 2014), it is associated with a higher risk of injury, dropout, and disengagement from physical activity (Myer et al., 2016). To counter the many negative effects of early specialisation, emerging football nations should encourage youngsters to diversify their learning experiences during the initial stages of development through sampling multiple sports and engaging in football through informal play activities (Côté et al., 2009b). This is not saying that youngsters should remove all football involvement from an early age but delay the onset of a high volume of training and use a majority of playful, and inherently fun activities to minimise the chance of players dropping out of the sport. A useful strategy is for sporting organisations to provide multi-sport programs during childhood allowing youngsters to self-discover, and be directed to, the most suitable sport for them. Again, this approach reduces the demands of talent identification and shifts the focus towards development, which allows the size of the talent pool to be maximised.

Mitigating confounding factors

Governing bodies and sporting organisations can implement several strategies to mitigate maturation biases (e.g. bio-banding and weighted performance ratings) and relative age effects (e.g. selection quota and age ordered shirt numbering). Bio-banding involves grouping players according to their physical attributes to minimise the influence of maturation and growth on performance (Cumming, Llyod, Oliver, Eisenmann, & Malina, 2017). Applying bio-banding to football seems to promote positive overall experiences, with early maturing players perceiving bio-banded competitions more challenging and later maturing players reporting a greater ability to influence the game and more confidence on the ball (Cumming et al., 2018). However, further research is needed to determine the specific advantages and disadvantages of bio-banding on players' physical, psychological, and social development (Reeves, Enright, Dowling, & Roberts, 2018). Two different practical examples of bio-banding are observed in the established football nations Belgium and England. The Belgium Football Association created the initiative whereby late developers were placed in a 'Futures' squad to promote their long-term retention in the Belgian talent pool. Another practical form of bio-banding observed in England is the use of chronological age and maturity-based national benchmarks for physical fitness data. For emerging football nations, where comprehensive databases of players' performance characteristics are not available, it would be beneficial to utilise the longitudinal data from countries like Belgium (Deprez et al., 2015b), England (Emmonds et al., 2016), or Germany (Höner et al., 2017) to create performance characteristic weightings based on biological maturity. Coaches and sporting professionals can then apply these weightings when assessing a player's talent status and reduce the chances of favouring more mature players.

Using these strategies to account for the confounding influences of maturation on players' performance characteristics is a valuable step forward for emerging football nations. However, it is essential that talent identification and development practices also account for relative age effects. Relative age effects can emerge from as early as 6 years (Helsen et al., 1998) and expand across most of youth development (Cobley, Baker, Wattie, & McKenna, 2009). As such, inter-individual differences can exist in not only the physical domain, but also in the motor, psychological and social domain. Fluctuating the selection cut-off dates could lessen the impact of older players dominating inclusion in talent development programs and academies (Helsen et al., 2012). Another practical strategy includes establishing selection quota where sporting organisations and academies are required to select a minimum number of players from each birth quartile. Alternatively, coaches and sporting professionals can provide players with age-ordered shirt numbers during the selection process, so they are explicitly aware of the informational constraints that confound their recruitment decisions (Mann & van Ginneken, 2017). Collectively, these strategies can prevent players being deselected due to factors outside of their control. However, it is imperative that future research determines: (1) how bio-banding impacts on long-term development, (2) the most appropriate weighting factor(s) for late maturing players' performance characteristics, and (3) the financial and logistical costs of modifying selection cut-off dates.

Tracking players' developmental trajectories

Many of the suggested strategies in this review emphasise the need for inclusive development over strict talent identification and selection. Therefore, emerging football nations should shift away from isolated assessment batteries and develop national, multifactorial protocols that follow players who display '*above average'* abilities throughout their development and into adulthood. Collecting these data allows for the careful evaluation of the various performance profiles which can result in developing football expertise. The longitudinal tracking of players can also assist with mitigating the confounding factors as an emphasis is placed on a player's growth rather than how they compare with other individuals in the development program. Furthermore, implementing a national, multifactorial assessment battery will allow for the development of a comprehensive database of promising youth footballers. This will encourage coaches and sporting professionals to look beyond their current squads and provide opportunities to players who develop outside the academy (i.e. side entry).

Conclusion

Football talent remains an incredibly difficult concept to extensively quantify. Despite talent identification and development being a well-documented research domain, there is a need to understand how established football nations' data applies to those who are emerging at an international level. Emerging football nations present unique challenges and it is important to re-evaluate the approaches used to identify and develop talent. Going forward, emerging football nations should prevent active deselection and dropout to maximise the size of the available talent pool, reduce the influence of confounding factors on talent identification, and longitudinally track players throughout development to document the range of performance profiles that lead to football expertise.

Practical implications

Talent identification and development in emerging football nations should:

- Mitigate confounding factors by providing developmental opportunities to players less biologically mature or those born late in the selection year
- Relax the selection criteria used in development programs to minimise active deselection
- Encourage youth footballers to specialise later and diversify their learning experiences during development to help reduce drop-out
- Develop national, multifactorial assessment protocols that follow players during development
- Carefully evaluate the structure and available resources in their national talent system

Chapter four:

Study two

The use of small-sided games to assess skill proficiency in youth soccer players: A talent identification tool

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"Study two addresses one of the major gaps reported in study one – a lack of valid soccer-specific skill assessments".

Abstract

This study adopted an exploratory approach to investigate the use of small-sided games as a talent identification tool to determine youth soccer players' skill proficiency. A total of 73 male youth soccer players (age = 13.3 ± 1.2 y) were sub-divided into two groups in accordance with their playing level (high-level: $n = 36$, low-level: $n = 37$). Within their levels, players completed 4 vs. 4 small-sided games on a 30 × 20 m playing surface under two conditions (condition 1: 5 × 3 minutes, condition 2: 3 × 5 minutes). Attempted and completed skill involvements were analysed using retrospective video analysis. Skill proficiency was determined as the total completed involvements relative to the amount attempted. Repeated measures multivariate analysis of variance identified that high-level players displayed a significantly greater number of attempted and completed passes ($p = 0.03$ and $\eta_p^2 = 0.09$; $p < 0.01$ and $\eta_p^2 = 0.17$, respectively), touches ($p = 0.01$ and $\eta_p^2 = 0.12$; $p < 0.01$ and $\eta_p^2 = 0.15$, respectively), and total skill involvements ($p = 0.01$ and $\eta_p^2 = 0.11$; $p < 0.01$ and $\eta_p^2 = 0.25$, respectively) when compared with low-level players. Only the number of attempted passes ($p = 0.04$ and $\eta_p^2 = 0.07$) and total involvements ($p = 0.04$ and $\eta_p^2 = 0.07$) differed between conditions. High-level players' total skill proficiency was significantly greater than their lower level counterparts ($p < 0.01$ and $\eta_p^2 = 0.29$). This study supports the use of small-sided games as a tool to assess soccer-specific skill proficiency, which coaches and sporting professionals can apply in a talent identification setting.

Keywords: football, selection, sport-specific skill, assessment, expertise

Introduction

Talent identification involves the ongoing process of recognising exceptionally gifted youngsters who display the potential to develop their gifts into talents following a period of systematic training (Vaeyens et al., 2008; Williams & Reilly, 2000). To identify gifted soccer players, talent identification programs assess characteristics related to excellence, which include anthropometry (e.g. stature, body mass, and body fat), physical fitness (e.g. muscular power, speed, agility, and aerobic endurance), motor coordination (e.g. balancing, jumping, and object manipulation), perceptual-cognitive skill (e.g. anticipation, decision-making, and game intelligence), domain-specific skill (e.g. dribbling, passing, and shooting), and psychological traits (e.g. goal motivation, anxiety control, and attentional style) (Williams & Reilly, 2000). Traditionally, a large focus is placed on physical characteristics (i.e. anthropometry and physical fitness) as high-level youth soccer players display superior muscular power, speed, and aerobic capacity when compared with those from a lower level (Coelho-e-Silva et al., 2010; Vaeyens et al., 2006). However, the use of these measures in isolation is questionable, as growth and maturation heavily influence them (Malina et al., 2015; Philippaerts et al., 2006).

The success of talent identification programs hinges on their ability to assess a range of performance-related characteristics (Vaeyens et al., 2008). Although various studies have implemented multifactorial designs when either distinguishing between playing levels or predicting future success (Coelho-e-Silva et al., 2010; Deprez et al., 2015b; Figueiredo et al., 2009a; Reilly et al., 2000; Vaeyens et al., 2006), many do not fully capture perceptual-cognitive and domain-specific skills. Numerous perceptual-cognitive and domain-specific skill assessments lack task representativeness, in other words, they lack transferability to in-game performance (Phillips et al., 2010). Typically, soccer-specific skill is examined by isolating aspects of match-play in a closed environment (e.g.

dribbling, passing, or shooting without opposition) (Reilly et al., 2000; Vaeyens et al., 2006). It is argued that this approach is merely an assessment of technique, rather than skill itself, as it isolates the motor component without any consideration for the perceptual-cognitive processes that precede it (Ali, 2011).

More ecologically valid assessment protocols such as the Loughborough Soccer Passing Test and the Loughborough Soccer Shooting Test have been developed to assess the multifaceted nature of soccer-specific skill (Ali et al., 2007). While these tests display clear discriminant validity in senior and adolescent soccer players (Ali, 2011; McDermott, Burnett, & Robertson, 2015), the transferability of skill performance is difficult to ascertain. Serpiello et al. (2017) reported very poor correlations between the Loughborough Soccer Passing Test scores and in-game passing performance (measured based on the number of touches before a pass, pressure on the player in possession, whether the player was moving, and pass location, direction, quality, and trajectory), indicating that a multitude of perceptual-cognitive processes underlie the successful execution of a specific skill in match-play. Therefore, it is imperative that soccer-specific skill is assessed in an environment that closely resembles competition.

One approach to assessing soccer-specific skills may be using small-sided games. Traditionally, small-sided games research has focused on the effect of manipulating task constraints (e.g. the number of players, duration and frequency of bouts, and field dimensions) on the physical, physiological, and technical requirements [see Hill-Haas, Dawson, Impellizzeri, and Coutts (2011) for a comprehensive review]. Although there is no consensus on the optimal methodological design for implementing small-sided games in youth soccer (Abrantes et al., 2012; Almeida et al., 2016; Christopher et al., 2016; Fanchini et al., 2011; Joo, Hwang-Bo, & Jee, 2016), their ecological validity as a skill assessment tool should be recognised. During small-sided games, players execute an array of soccer-specific actions in response to a modified competitive environment. Typically, in this environment players have greater skill opportunities when compared with match-play (Joo et al., 2016), which presents a means for coaches and sporting professionals to sufficiently measure skill proficiency (i.e. the number of completed skill involvements relative to the number attempted). Currently, researchers (Fenner et al., 2016; Unnithan et al., 2012) who use small-sided games as a talent identification assessment tool have focused on the development of a simplistic metric (i.e. total points) to quantify performance. The total points accumulated across multiple games were suggested to be a practical measure for talent identification as they showed a very large relationship with player's technical ability (as determined by the Game Technical Scoring Chart). While this method presents a simplistic assessment tool, it is important that research examines the discriminant validity of small-sided games to determine if skill proficiency measures are sensitive to playing level differences.

Therefore, the aim of this study was to investigate the use of small-sided games as a talent identification tool. First, this study used two types of small-sided games to compare the skill proficiency of youth Australian soccer players from two academies. Second, this study aimed to investigate if the assessment of skill proficiency using small-sided games is dependent on the number and duration of bouts. It was hypothesised that high-level players would display significantly higher skill proficiency compared with players belonging to a lower level youth academy. In addition, it was hypothesised that players would be able to maintain their skill proficiency across different small-sided games.

Methods

Participants

Data were collected from male youth soccer players aged 11 to 15 years (*n* = 73, age = 13.3 ± 1.2 y). Players were sub-divided into two groups depending on the structure of their academy and playing level. The high-level academy (*n* = 36) consisted of players who were under the guidance of a professional club and were supported by nationally and internationally accredited coaches (i.e. FFA – Pro Diploma and A licence) over 48 weeks of the year. Players in this academy received approximately 6 hours of coach-led technical and tactical practice per week (i.e. 4 × 1.5 h sessions) and contested a state-based National Premier League in a division one year older than their chronological age (final ladder position in 2016: under-12 = not involved in the 2016 National Premier League; under-13 = 4th and premiers; under-14 = 3rd and grand finalists; and under-15 = 2nd and grand finalists). The low-level academy (*n* = 37) contained players who were registered with a local club that received regionally and nationally accredited coaching support (i.e. FFA – B and C Licence) over 36 weeks of the year. Players in this academy were exposed to approximately 4 hours of coach-led technical and tactical training per week (i.e. 2 × 2-hour sessions) and contested the same state-based National Premier League, however were involved in their normal chronological age division (final ladder position in 2016: under-12 = not involved in the 2016 National Premier League; under-13 = 10th; under-14 = 10th; and under-15 = 11th). Within their academy, players were randomly selected to remove the influence of coaching bias. If a player became unavailable during data collection, a suitable replacement was sought. All players and their parents or legal guardians were informed of the aims and the requirements of the research and provided written consent. The Institutional Ethics Research Committee approved this study (ETH16-0634).

Experimental procedures

Small-sided games

The methodological design of the small-sided games protocol was selected after analysis of previous research (Abrantes et al., 2012; Almeida et al., 2016; Christopher et al., 2016; Fanchini et al., 2011; Fenner et al., 2016; Joo et al., 2016; Unnithan et al., 2012) and discussions with the internationally accredited coaching staff from the high-level academy. Players completed two duration matched small-sided games (condition 1 = 5 × 3 minutes; condition 2: 3 × 5 minutes) on two separate occasions (minimum period of 72 hours between sessions). Rest intervals were matched to the bout duration to maintain a 1:1 work to rest ratio and minimise the influence of fatigue. Within playing levels, the randomly selected players were divided into two teams of four, which remained constant throughout the data collection period. Small-sided games were completed on the team's normal training surface (high-level: 3rd generation artificial grass, low-level: natural grass) with the field dimensions set at 30 m long by 20 m wide (total area = 600 m^2, area per player 75 m^2). These field dimensions are like those commonly used with youth soccer players aged 12 to 16 years (Abrantes et al., 2012; Almeida et al., 2016; Unnithan et al., 2012). Modified soccer goals (2.4 m wide by 1.2 m high) were set up at each end. A multi-ball system surrounding the field was implemented to ensure the speed of play was maintained across the total duration. All players received standardised instructions of the purpose of the game (i.e. to contest each bout as if it was a normal competitive match), however were unaware of the skill proficiency measures being recorded or the duration of each bout. Players commenced each session by undertaking a standardised warm-up (FIFA 11+). Coach encouragement or feedback was not permitted throughout the small-sided games.

Skill proficiency measures

A skill assessment criterion was developed to maintain an objective analysis process. Functional game skills designated in FFA's National Football Curriculum were included to provide an overall quantification of the 'ball in possession' component of youth match-play. Skills were divided into two categories: the number of times a skill was used within a game, irrespective of whether it was successful or not (i.e. attempted); and the number of times a skill was successful in a game (i.e. completed). A completed skill involvement was classified as (1) Dribble – a player in possession of the ball travels more than two steps in any direction without being tackled by a defender; (2) Pass – a player in possession of the ball delivers a timed pass to a supporting player using their head, chest, knee, or foot; (3) Touch – a player gains control of the ball following the completion of a pass or the interception of a pass using their head, chest, knee, or foot; and (4) Shot - a player in possession of the ball scored a goal using their head, chest, knee, or foot. Video files (Legria HG40, Canon, Japan) of the small-sided games were analysed using VLC media player (Version 2.2.4, VideoLan Organisation, France) and a customised Microsoft macro-based Excel spreadsheet. Players' performance within conditions was quantified by summating the skill involvements for each bout. Total attempted and completed skill involvements were calculated by summating the number of dribbles, passes, touches and shots. Skill proficiency was determined as the total completed skill involvements relative to the amount attempted.

Reliability of the skill analysis procedures

The reliability of the analysis process was assessed through the coding of one small-sided games condition on two separate occasions. Re-test trials were conducted two weeks apart to minimise the effect of learning and retention of information. Differences between trials were identified using a repeated measures analysis of variance (RM-MANOVA).

Consistency of the analysis procedures was determined using the change in mean and intra-class correlation coefficients (95% confidence intervals). Only the number of dribbles attempted was deemed to be significantly different between trials ($p < 0.01$). However, the magnitude of difference (Cohen's d) between trials were *trivial* (i.e. < 0.20) to *small* (i.e. 0.2 to 0.5) for all variables. The strength of the correlation coefficient was considered as *strong* (i.e. < 8.0% of the variance in the data were explained by error) for all variables. Therefore, all skill involvement measures were retained for subsequent analyses (Table 4.1).

Table 4.1. The intra-rater reliability of the skill analysis process.

Skill	**Δ mean**	**F**	***ES***	**ICC (95 % CI)**
Attempted				
Dribble	-1.25	15.91*	0.24	0.99 (0.93 – 1.00)
Pass	0.88	2.54	0.08	0.99 (0.95 – 1.00)
Touch	-0.63	1.38	0.17	0.92 (0.64 – 0.98)
Shot	0.00	0.00	0.00	0.99 (0.93 – 1.00)
Overall	-1.00	1.87	0.08	0.99 (0.94 – 1.00)
Completed				
Dribble	-0.88	4.83	0.20	0.97 (0.85 – 0.99)
Pass	0.50	0.54	0.05	0.98 (0.89 – 1.00)
Touch	-0.13	0.52	0.03	0.93 (0.67 – 0.98)
Shot	-0.13	1.00	0.10	0.96 (0.83 – 0.99)
Overall	-0.63	1.00	0.05	0.99 (0.94 – 1.00)

Note: * denotes a significant difference ($p < 0.05$) between re-test trials.

Statistical analysis

Assumptions of normality were assessed using a Shapiro-Wilk test and visual inspection of Q-Q plots and histograms of all dependent variables. Preliminary analyses using multivariate analysis of variance (MANOVA) were undertaken to determine the influence of age group × academy on the specific and total skill involvements (attempted and completed) within conditions. There was no multivariate effect for age group on specific or total skill involvements for condition 1 or 2 (specific: condition 1 – F = 0.59, $p = 0.93$, $\eta_p^2 = 0.09$; condition 2 – F = 1.01, $p = 0.46$, $\eta_p^2 = 0.143$; total: condition 1 – F = 0.54, $p = 0.78$, $\eta_p^2 = 0.03$; and condition 2 – F = 0.54, $p = 0.78$, $\eta_p^2 = 0.03$; respectively). Therefore, to optimise statistical power, data were pooled (i.e. presented as one sample rather than individual age groups) for each academy. The following analyses were divided into three sections. First, a RM-MANOVA assessed the influence of playing level (between-subject) and condition (within-subject) on the specific skill involvements. Second, a RM-MANOVA examined the influence of playing level and condition on total skill involvements. Finally, a RM-MANOVA evaluated the influence of playing level and condition on skill proficiency. Alpha (p) was set at < 0.05. Partial Eta Squared effect sizes (η_p^2) were evaluated as *small* = 0.01, *moderate* = 0.06 and *strong* = 0.14 (Cohen, 1988). Where main effects were evident, Bonferroni *post-hoc* corrections were applied to allow for multiple comparisons and to observe individual differences. All statistical analyses were conducted using SPSS software (Version 23.0, IBM Corporation, United States of America).

Results

Specific skill involvements

The mean ± SD was calculated for all data (Table 4.2). A significant multivariate effect was identified for playing level on the number of attempted and completed skill involvements (F = 3.19, $p < 0.01$, $\eta_p^2 = 0.98$). Playing level influenced the number of attempted and completed passes and touches ($p = 0.03$ and $p < 0.01$; $p = 0.01$ and $p < 0.01$; respectively). Specifically, the high-level players displayed more attempted and completed passes and touches when compared with their low-level counterparts. A significant multivariate effect was not evident for condition on the number of attempted or completed skill involvements. A significant multivariate interaction effect was not apparent for specific skill involvements, yet a univariate interaction effect was evident for playing level and condition on the number of attempted passes ($F = 4.45$. $p = 0.04$, $\eta_p^2 = 0.08$). High-level players attempted more passes in condition 1 when compared with condition 2.

Total skill involvements

A significant multivariate effect was identified for playing level on the attempted and completed total skill involvements ($F = 13.18$, $p < 0.01$, $\eta_p^2 = 0.34$). A *moderate* and *strong* univariate effect was evident for playing level on the number of attempted and completed total skill involvements ($p = 0.01$ and $p < 0.01$, respectively). Specifically, both categories of total involvements were greater in the high-level academy when compared with their low-level counterparts. Multivariate effects of condition on total skill involvements were not apparent. Univariate analysis identified a significant *moderate* effect of condition on the number of attempted total skill involvements ($p = 0.04$). Both levels total attempted skill involvements were higher in condition 1 when compared with condition 2. Interaction effects were not apparent for total skill involvements.

Table 4.2. The attempted and completed skill involvement of youth soccer players during two small-sided games conditions (mean ± SD).

	Condition 1 (5 x 3 minutes)		Condition 2 (3 x 5 minutes)		Playing level		Condition	
	High-level	**Low-level**	**High-level**	**Low-level**	**F**	**η_p^2**	**F**	**η_p^2**
Attempted								
Dribble	10.9 ± 4.3	10.9 ± 5.8	10.5 ± 5.0	9.6 ± 5.7	0.17	0.00	1.83	0.03
Pass	28.8 ± 7.9	23.1 ± 5.9	25.5 ± 7.5	23.9 ± 6.1	5.16*	0.09	1.71	0.03
Touch	21.6 ± 5.1	18.6 ± 4.9	19.7 ± 4.8	17.3 ± 5.7	6.92*	0.12	2.95	0.05
Shot	5.0 ± 3.0	6.1 ± 3.1	5.4 ± 3.5	4.8 ± 3.3	0.09	0.00	1.32	0.02
Total	66.4 ± 10.9	58.6 ± 14.6	61.2 ± 11.5	55.5 ± 12.2	6.40*	0.11	4.26*	0.07
Completed								
Dribble	8.6 ± 3.7	7.6 ± 4.8	8.1 ± 4.3	6.7 ± 4.7	1.36	0.03	1.35	0.03
Pass	24.1 ± 6.9	17.8 ± 4.9	21.1 ± 7.0	17.9 ± 6.2	10.88**	0.17	2.71	0.05
Touch	18.8 ± 4.6	15.9 ± 4.7	18.0 ± 4.9	14.9 ± 5.2	9.30**	0.15	1.05	0.02
Shot	2.1 ± 1.4	1.7 ± 1.9	2.9 ± 2.8	1.6 ± 1.6	3.25	0.06	1.45	< 0.01
Total	53.5 ± 9.9	43.0 ± 11.8	49.7 ± 10.3	41.1 ± 10.3	17.84**	0.25	2.79	0.05

Note: High-level academy (n = 28), low-level academy (n = 27). * denotes a significant ($p < 0.05$) univariate effect. ** denotes a significant ($p < 0.01$) univariate effect.

Total skill proficiency

A significant univariate effect was evident for playing level on skill proficiency (F = 21.51, $p < 0.01$, $\eta_p^2 = 0.29$). The high-level players demonstrated a greater skill proficiency when compared with their low-level counterparts in condition 1 and 2 (Figure 4.1). Multivariate effects were not apparent for small-sided games condition on skill proficiency. No multivariate interaction effects were identified for playing level and small-sided games condition on skill proficiency.

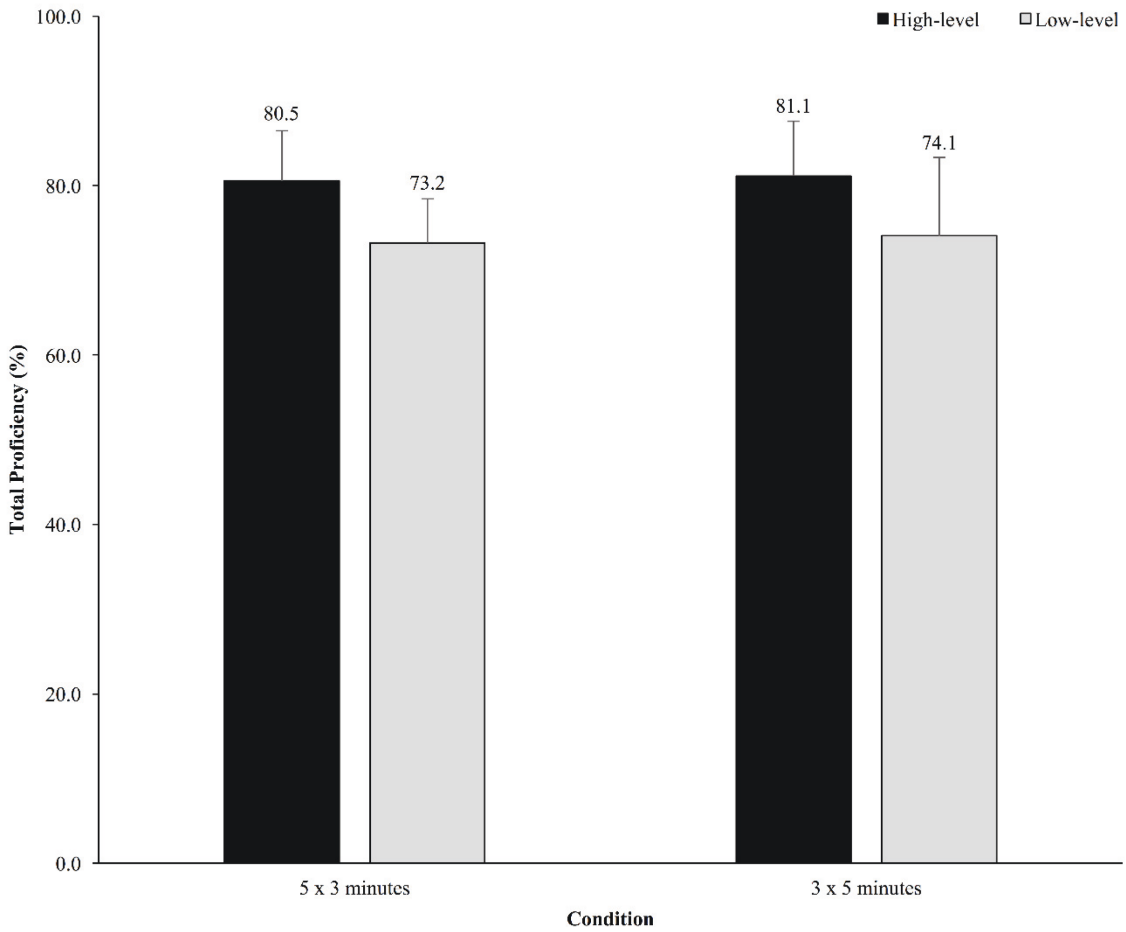

Figure 4.1. The skill proficiency of youth soccer players during two small-sided games conditions.

Discussion

The aim of this study was to investigate the use of small-sided games as a talent identification tool to determine youth soccer players' skill proficiency. It was hypothesised that high-level players would display higher skill proficiency when compared with those from a lower level. In addition, it was hypothesised that these players would be able to maintain their skill proficiency across different small-sided games conditions. Overall, high-level players attempted and completed more passes, touches, and total skill involvements in both small-sided games conditions when compared with low-level players. These high-level players possess a higher skill proficiency irrespective of small-sided games condition. The small-sided games condition had minimal influence on the amount of attempted and completed skill involvements. The inclusion of small-sided games as part of a multifactorial assessment battery may provide useful information to coaches and sporting professionals about the potential of a young soccer player.

The findings from this study support the discriminant validity of small-sided games as a talent identification tool for measuring skill proficiency. High-level players displayed proficient skill behaviours for soccer-specific actions related to passing and controlling the ball, along with completing more total involvements. This study's methodological approach provides coaches with a simplistic way of assessing soccer-specific skills in a practical setting. It should be noted that players contested small-sided games within a set team like they would if they were competing in a competition match. Set teams allow for players to self-discover technical and tactical strategies for problem solving with their teammates to meet the constraints of the small-sided games (i.e. playing numbers, field dimensions, and rules) and adapt these as the relationship with their teammates develops (Davids et al., 2013). As players in a talent identification setting often develop with the same teammates, it seems logical to use set teams within small-sided games. However, it is important for future research to also investigate the use of small-sided games for measuring skill proficiency when players compete in randomised teams. Randomising teams will likely impose different technical and tactical constraints on players as they will have to adapt their behaviour according to the proficiency of their teammates. This approach may allow coaches to determine the cooperative nature of players with a diverse number of individuals.

This study adopted an exploratory approach to determine if the small-sided games condition (i.e. 5 × 3 minutes and 3 × 5 minutes) affected the skill proficiency of players. This approach was important as it helps to determine the external validity and applicability of small-sided games as an assessment tool. Although, the small-sided games condition had a minimal influence on skill proficiency, there were more opportunities for passing and total involvements in condition 1 when compared with condition 2 for high-level players. This finding should be highlighted as more skill opportunities potentially increase the task representativeness as they require greater involvement in situations encompassing decision-making and the execution of soccer-specific actions (Travassos et al., 2012c). If players can maintain a high skill proficiency while problem-solving more frequently, it could be argued that these players show potential for future technical and tactical development. Previous research investigating the number of skill opportunities available in small-sided games has reported no differences in the technical actions (i.e. pass, dribble, interception, tackle, header, turn, shot, and shot on target) when increasing the bout duration from 2 to 6 minutes (Fanchini et al., 2011). Similarly, Christopher et al. (2016) reported no differences in technical actions (i.e. pass, successful pass, unsuccessful pass, shot, shot on target, goals, individual possessions, and regains) between 4 bouts of 2 minutes and 2 bouts of 4 minutes. Together, these findings have significant implications for talent identification programs. It is possible that bout durations of less than 6 minutes may not have a major influence on the skill opportunities within a small-sided game. Therefore, coaches and sporting professionals can implement different duration small-sided games depending on the time-constraints of the assessment period while having little influence on the skill proficiency of players.

Limitations

When interpreting the findings of this study, some limitations must be considered. First, the smoother surface of the artificial pitch may have allowed for less variability in the movement of the ball (e.g. the ball bouncing in a pass due to hitting an uneven surface). This coupled with the imposed small-sided games constraints (i.e. number of players, pitch dimensions, and bout duration and frequency) likely influenced the players' skill behaviours (Abrantes et al., 2012; Almeida et al., 2016; Christopher et al., 2016; Fanchini et al., 2011; Joo et al., 2016). Second, the employed approach to measuring skill proficiency using count data is relatively novel. Currently, few studies have investigated the transfer of skill performance from small-sided games to match-play. Third, this study only examined offensive skills as this is a large focus of the National Football Curriculum in Australia. Therefore, future research is needed to determine if small-sided games are useful for distinguishing between playing levels for defensive skills. Finally, player's maturity status could have confounded the observed findings. However, it should be noted that (da Silva et al., 2011) reported no significant correlation between maturity status and technical performance during small-sided games.

Conclusion

This study was the first to examine the applicability of small-sided games as an assessment tool to determine the skill proficiency of youth soccer players. It was observed that players from the high-level academy displayed a significantly greater number of attempted and completed passes, touches, and overall skill involvements when compared with low-level players. In addition, skill proficiency remained relatively constant across different small-sided games, however attempted passes and overall involvements were lower in the condition consisting of 3 bouts of 5 minutes for high-level players. Collectively, these findings support the use of small-sided games as a skill assessment tool for talent identification purposes. The information gained from such assessments can assist coaches in determining the potential of youth soccer players.

Practical implications

These findings have important implications for coaches and sporting practitioners working in the field of talent identification. Small-sided games can be implemented as part of a multifactorial testing battery to provide a measure of skill proficiency. Implementing small-sided games with frequent bouts of short duration (i.e. 5 × 3 minutes) may provide the greatest opportunity for players to be involved and allows for an adequate assessment of skill proficiency. Practically, this assessment protocol can be used on large-scale testing days as it does not require a substantial amount of time. Using a staggered start, four teams can complete their skill proficiency assessments in a 30-minute period: team one and two contest the first small-sided games bout, followed by team three and four in the first games rest period. This process is repeated a further four times to make up a total of five bouts. The video footage obtained from these small-sided games can be analysed retrospectively using simplistic performance analysis techniques (i.e. notational analysis in Microsoft Excel) or outsourced to external organisations (e.g. Prozone). While information gained from these assessments appear promising, these results should not be interpreted in isolation and should be used to guide the subjective opinion of the coaching staff.

Chapter five:

Study three

Assessing the validity of a video-based decision-making assessment for talent identification in youth soccer

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"Study three addresses the other major gap identified in study one – a lack of valid perceptual-cognitive skills assessments".

Abstract

The current study investigated the construct and discriminant validity of a video-based decision-making assessment for talent identification in youth soccer. A total of 328 tier one (n = 119, age = 12.1 ± 2.6 y), tier two (n = 171, age = 13.2 ± 1.7 y), and tier three (n = 38, age = 14.2 ± 1.5 y) academy youth soccer players (from three developmental stages (late childhood: 8.0 – 10.9 y, early adolescence: 11.0, 13.9 y, and mid-adolescence: 14.0 – 16.9 y) participated in this study. The control group consisted of 59 youth athletes (age = 14.3 ± 1.2 y) with no soccer experience in the last five years. Players completed a video-based decision-making assessment on an iPad, with response accuracy and time recorded for various attacking situations (2 vs. 1, 3 vs. 1, 3 vs. 2, 4 vs. 3, and 5 vs. 3). The video-based decision-making assessment showed some construct validity. Response times were significantly faster in the early and mid-adolescent players when compared with those in the late childhood group ($p < 0.01$ and $\eta_p^2 = 0.08$). Furthermore, an overall decline in decision-making performance (i.e. decrease in response accuracy and increase in response time) was observed from the 2 vs. 1 to the 5 vs. 3 situations. The video-based decision-making assessment lacked discriminant validity as minimal differences between academies were evident in response accuracy and response time. Only response accuracy was able to discriminate youth academy soccer players from the control group to some extent ($p < 0.01$ and $\eta_p^2 = 0.12$; $p < 0.01$ and $\eta_p^2 = 0.19$). Coaches and sporting professionals should apply caution when interpreting data from practical, video-based decision-making assessments. There is currently limited conclusive evidence supporting the effectiveness of these assessments for talent identification.

Keywords: football, expertise, perceptual-cognitive skills, task representative

Introduction

Association football (soccer) is a popular team invasion sport where many youngsters pursue their aspirations of becoming elite performers. The attainment of soccer-specific expertise is multifactorial (Simonton, 1999), with the unique individual-dependent interaction between the environment and the imposed task demands underpinning successful performance (Phillips et al., 2010). On an individual level, players' performance characteristics – including their anthropometry, physical fitness, soccer-specific skills, perceptual-cognitive skills, and psychological traits – are used as a measure of soccer-specific expertise (Vaeyens et al., 2008; Williams & Reilly, 2000). Researchers, coaches, and sporting professionals typically implement both objective (Deprez et al., 2015b; Höner & Feichtinger, 2016) and subjective (Christensen, 2009; Larkin & O'Connor, 2017) assessments to quantify players' performance characteristics. While these data frequently inform recruitment decisions into high-level academy programs, a significant limitation of current methodologies is the lack of valid perceptual-cognitive skills data.

Perceptual-cognitive skills (e.g. anticipation, pattern recognition, game intelligence, and decision-making) are integral to a player's ability to make decisions and execute soccer-specific skills during competitive match-play; where the performance environment is complex and rapidly changing (Araújo et al., 2006; Mann et al., 2007). During competitive match-play, decision-making involves players perceiving and interpreting environmental information – relative to the positioning of the ball, their teammates, and opposing players – and executing specific actions appropriate to the imposed task demands (Davids et al., 2013; Travassos et al., 2012a; Travassos, Araújo, Duarte, & McGarry, 2012b). Importantly, players in invasion sports like soccer, perform skills in a reciprocal and sequential manner (e.g. controlling the ball following a pass from a teammate, dribbling the ball into space, and taking a shot on goal), meaning that a phase of play can involve frequent decision-making moments that are continually adapted according to perceptual information in the performance environment. Due to the complexity of the perceptual-cognitive skills underpinning decision-making in match-play, designing task representative methodologies that truly encapsulate the entire decision-making process is difficult.

Advancements in video technology has offered researchers the opportunity to develop task representative perceptual-cognitive and decision-making assessments. To date, these assessments have involved players either verbalising/writing the most appropriate response (Keller et al., 2018b; O'Connor et al., 2016; van Maarseveen, Oudejans, & Savelsbergh, 2015) or executing a soccer-specific skill (Vaeyens et al., 2007a; Vaeyens et al., 2007b; Vänttinen et al., 2010) after viewing video footage of a simulated match-based situation. Collectively, high-level soccer players within these tasks better anticipate the actions of their opponents, more effectively adapt their visual search strategies according to the complexity of the situation, initiate a response action quicker, and make more favourable decisions, when compared with their low-level counterparts. Although these findings provide valuable insights into youth soccer players' perceptual-cognitive skills, applying such methodologies in talent identification is not straightforward. As coaches have limited opportunities to comprehensively assess promising players, the use of large projection screens, pressure sensors, eye-tracking technology, and verbal reports are often impractical. In addition, there is limited data on many of the employed assessments' validity, making it difficult to determine whether the assessment is measuring what it claims to measure. Consequently, it is warranted that future research examines multiple components of video-based decision-making assessments' validity and determines practical methods for delivering these assessments in talent identification.

Therefore, the current study's primary aim was to evaluate the use of mobile technology as an alternate method of delivering video-based decision-making assessments for talent identification. First, the influence of developmental stage, the number of years playing soccer, and situation on decision-making performance was examined (i.e. construct validity). It was hypothesised that older players would have superior decision-making performances (i.e. a higher response accuracy and a faster response time) when compared with younger players. Furthermore, it was hypothesised that superior decision-making performance would be associated with a greater number of years playing soccer. It was also expected that situations involving more players (i.e. a higher number of stimulus-response choices) would result in lower response accuracy and slower response time, when compared with situations involving less players. Second, it was determined if the practical video-based decision-making assessment could discriminate players based on their academy status (i.e. discriminant validity). It was hypothesised that high-level academy players would display better decision-making performances than low-level academy players. It was also expected that all academy players would outperform a group of non-soccer players on the assessment.

Methods

Participants

Participants were 328 male youth soccer players from three academy systems: tier one players were members of an A-league academy (n = 119, age = 12.1 ± 2.6 y), tier two players were members of a National Premier League academy (n = 171, age = 13.2 ± 1.7 y), and tier three players were members of a local academy (n = 38, age = 14.2 ± 1.5 y). An additional 59 youth athletes (age = 14.3 ± 1.2 y) with no competitive soccer experience in the last five years formed the control group. All participants were assigned to one of three developmental stages depending on their chronological age: late childhood (8.0 –

10.9 y), early adolescence (11.0 – 13.9 y), and mid-adolescence (14.0 – 16.9 y). Prior to completing the decision-making assessment, all players recorded their number of years playing soccer (range = 1 – 12 y). Participants and their parents or legal guardians were informed of the aims and the requirements of the research prior to providing written consent. The Institutional Ethics Research Committee approved this study (ETH16-0634).

Decision-making assessment

A decision-making assessment was developed using videos from previous studies (Vaeyens et al., 2007a; Vaeyens et al., 2007b). The videos were embedded into a customised iOS application using C# programming language and deployed to an iPad Mini 2 (Model A1432, Apple Inc., California, United States of America) using Xcode's (Version 9.1, Apple Inc., California, United States of America) integrated development environment. The application contained a standardised walk-through (task description, instructions on how to respond, and a troubleshooting guide) to ensure players understood the task at hand and to account for individual differences in the responsiveness to a novel assessment. From the original pool of 58 videos, 35 were randomly selected for the decision-making assessment. One video from each attacking situation was used as familiarisation trials, with the remaining 30 (2 vs. 1 = 4, 3 vs. 1 = 9, 3 vs. 2 = 6, 4 vs. 3 = 5, and 5 vs. 3 = 6) presented in a random order. A one second freeze frame preceded the videos to allow players to discover the location of the ball, teammates, and opposing players. The average duration of the attacking situations was 5.7 ± 1.2 s. A yellow training bib identified the key decision-maker that was pivotal to the outcome of each situation. The assessment paused at the critical decision moment, the point where the yellow player received the ball and was required to decide on an appropriate response. Responses were presented in the form of interactive buttons, with pass options appearing in the last known location of the yellow player's teammates, the dribble button on top of the yellow player, and the shoot button in the location of the goal. The number of available responses varied from two to five depending on the number of participating players. All players were instructed to quickly select the response that would directly lead to a goal scoring opportunity (i.e. a response where the yellow player could score a goal or assist a teammate in the scoring of a goal). A goal scoring opportunity was available in all videos.

Dependent variables

Response accuracy was measured on a multiple point scale (Vaeyens et al., 2007a; Vaeyens et al., 2007b). Two nationally accredited coaches (one FFA Pro Diploma coach and one FFA A Licence coach) and one internationally accredited coach (UEFA A licence) independently decided on the scoring of each video. Three points were allocated to the response that would directly lead to a goal scoring opportunity. Typically, three-point responses involved the player wearing the yellow bib shooting at goal, dribbling past a defender to shoot, or passing the ball to an unmarked teammate to shoot. Two points were allocated to responses that could indirectly lead to a goal scoring opportunity. These responses included a sequence of play that requiring one or two passes to create a shooting opportunity or dribbling the ball to create space for teammates to shoot at goal. One point was allocated to any response that allowed the team to maintain possession of the ball. It was deemed unlikely that these responses would lead to a goal scoring opportunity. Zero points were allocated to any response that would result in a loss of possession. Zero point responses usually involved the yellow player shooting or dribbling while closely marked or selecting a passing option where the receiving players were heavily marked. Overall, the three coaches agreed on the scoring of the videos (83%). Response time was recorded as the duration between the occlusion of a video and the player selecting a response on the iPad.

Statistical analysis

A Kolmogorov-Smirnov test and visual inspection of the Q-Q plots/histograms identified a non-normal distribution of the dependent variables and a considerable number of outliers. A lack of agreement on how to define outliers in the research exists. However, this study used an outlier labelling rule (lower limit = percentile 25 − 3 × interquartile range; upper limit = percentile 75 + 3 × interquartile range) to identify any extreme response accuracy and time values – an observation outside these limits is expected to occur in only one out of 425,000 observations (Boslaugh & Watters, 2008). These outliers were removed from subsequent analyses as their data likely represented input errors (i.e. missed the response button or a lapse in attention). Although there was a violation in the assumptions of multivariate normality, generalised linear models were preferred over non-parametric statistics in accordance with the Central Limit Theorem. This theorem states that the sample distribution of the sample mean approximates normal distribution when the sample size is sufficiently large, which is the case for the current study (Glass, Peckham, & Saunders, 1972).

A repeated measures multivariate analysis of covariance examined the construct validity of the assessment. This analysis determined the influence of developmental stage (between-subjects) and situation (within-subjects) on response accuracy and response time (dependent variables), while accounting for the number of years playing soccer (covariate). The control group was not included in construct validity analyses. Due to an insufficient representation of each academy in the late childhood group, discriminant validity was only investigated in early and mid-adolescent players. Two RM-MANOVA examined the influence of academy status (between-subjects) and situation (within-subjects) on response accuracy and response time (dependent variables) in early and mid-adolescent players. Bonferroni *post-hoc* corrections were applied to allow for multiple comparisons and to determine individual differences. As Mauchly's test of sphericity indicated a violation of the homogeneity of variance assumption for general linear models, and given the previous violation of the assumptions of normality, multivariate effects were interpreted using Pillai's trace corrections (Olson, 1974), and within-subjects effects using Huynh-Felt corrections when $\varepsilon > 0.75$ and Greenhouse-Geisser when $\varepsilon < 0.75$. An alpha of $p < 0.05$ was set for all analyses. Partial Eta Squared effect sizes were evaluated as *small* = 0.01, *moderate* = 0.06 and *strong* = 0.14 (Cohen, 1988). All statistical analyses were conducted using SPSS software (Version 24.0, IBM Corporation, United States of America).

Results

Construct validity

A significant interaction effect for developmental stage and situation was evident on response accuracy and response time (F = 1.92, $p = 0.01$, $\eta_p^2 = 0.07$). A significant interaction effect was also evident for the number of years playing soccer and situation on response accuracy and response time (F = 2.70, $p = 0.02$, $\eta_p^2 = 0.05$). Multivariate effects were identified for developmental stage (F = 5.73, $p < 0.01$, $\eta_p^2 = 0.04$), the number of years playing soccer (F = 6.28, $p < 0.01$, $\eta_p^2 = 0.04$), and situation (F = 26.16, $p < 0.01$, $\eta_p^2 = 0.43$) on response accuracy and response time. Univariate effects were evident for the interaction between developmental stage and situation on response time (F = 4.05, $p < 0.01$, $\eta_p^2 = 0.03$). Univariate effects were also evident for the interaction between the number years playing soccer and situation on response accuracy (F = 3.95, $p = 0.01$, $\eta_p^2 = 0.01$) and response time (F = 3.77, $p = 0.01$, $\eta_p^2 = 0.01$). Multiple comparisons revealed no differences for response accuracy in each developmental stage (Figure 5.1). Response times were faster in the early and mid-adolescent players when compared to those in the late childhood group. Response accuracy and response time significantly differed between situations, except between 4 vs. 3 and 5 vs. 3 (Figure 5.2).

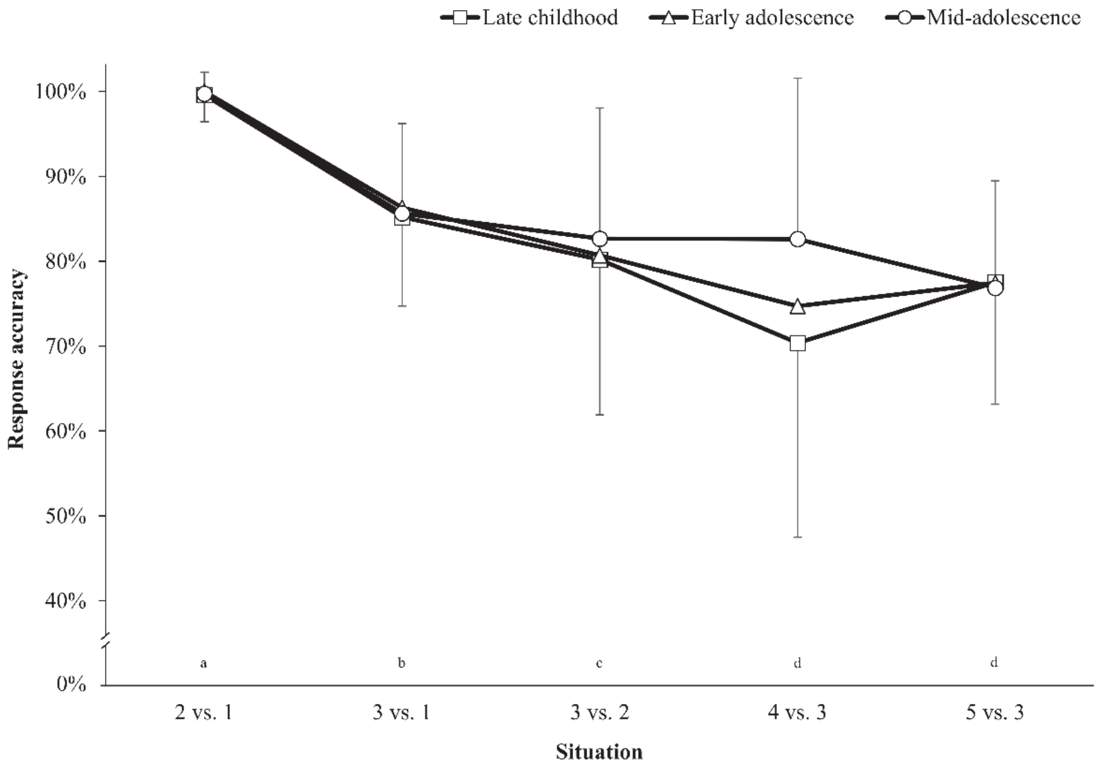

Figure 5.1. The effect of developmental stage and situation on youth academy soccer players' response accuracy (mean ± SD). Situations with the same superscripts are not significantly different ($p > 0.05$).

Discriminant validity

A significant interaction effect for academy status and situation on response accuracy and response time was evident (early adolescence: F = 2.10, $p < 0.01$, $\eta_p^2 = 0.10$, and mid-adolescence: F = 2.37, p < 0.01, $\eta_p^2 = 0.14$). Significant multivariate effects were identified for academy status (early adolescence: F = 5.38, $p < 0.01$, $\eta_p^2 = 0.09$, and mid-adolescence: F = 8.53, $p < 0.01$, $\eta_p^2 = 0.17$) and situation (early adolescence: F = 106.03, $p < 0.01$, $\eta_p^2 = 0.85$, and mid-adolescence: F = 93.19, $p < 0.01$, $\eta_p^2 = 0.86$). Univariate effects were also evident for the interaction between academy status and situation on response accuracy (early adolescence: F = 5.28, $p < 0.01$, $\eta_p^2 = 0.09$, and mid-adolescence: F = 8.14, $p < 0.01$, $\eta_p^2 = 0.16$). Situation significantly influenced response accuracy (early adolescence: F = 84.52, $p < 0.01$, $\eta_p^2 = 0.35$, and mid-adolescence: F = 61.32, $p < 0.01$, $\eta_p^2 = 0.33$) and response time (early adolescence: F = 50.03, $p < 0.01$,

$\eta_p^2 = 0.24$, and mid-adolescence: $F = 50.03$, $p < 0.01$, $\eta_p^2 = 0.24$). Multiple comparisons revealed that early and mid-adolescent academy players were more accurate when compared with the control group (Table 5.1). The tier two academy players responded significantly faster than the tier one academy players.

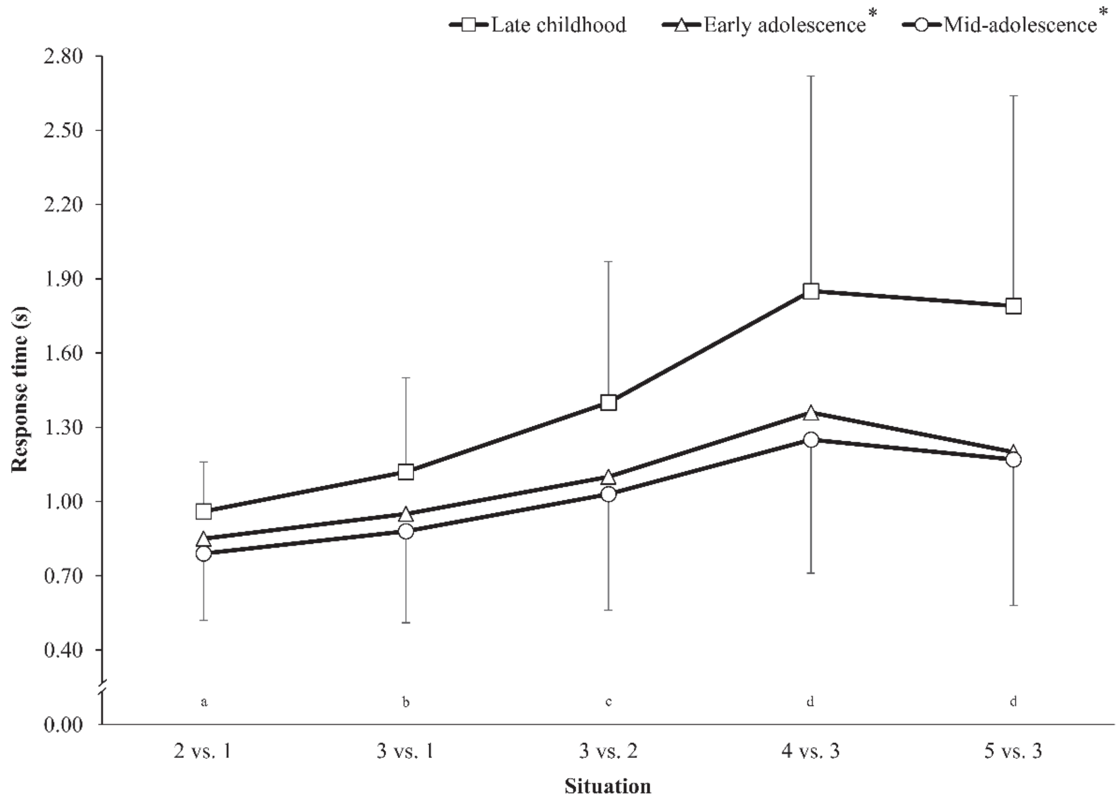

Figure 5.2. The effect of developmental stage and situation on youth academy soccer players' response time (mean ± SD). * indicates a significant difference ($p < 0.05$) from the late childhood group. Situations with the same superscript are not significantly different ($p > 0.05$).

Table 5.1. Early and mid-adolescent youth soccer players' decision-making performances from three academies and a control group (mean ± SD).

	Early adolescence				Mid-adolescence			
Dependent variable	**Tier one**	**Tier two**	**Tier three**	**Control**	**Tier one**	**Tier two**	**Tier three**	**Control**
Response accuracy (%)	*	*	*		*	*	*	
2 vs. 1	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	99.5 ± 3.4	100.0 ± 0.0	99.2 ± 4.6
3 vs. 1	85.4 ± 10.4	87.0 ± 10.1	84.8 ± 11.8	80.9 ± 11.3	83.6 ± 10.8	87.0 ± 9.1	84.9 ± 14.7	81.9 ± 13.3
3 vs. 2	77.2 ± 15.3	81.3 ± 13.5	83.3 ± 13.6	80.8 ± 14.0	79.4 ± 17.0	83.3 ± 15.6	86.7 ± 10.2	78.7 ± 14.4
4 vs. 3	79.3 ± 20.2	74.9 ± 23.6	67.0 ± 26.0	49.7 ± 21.8	86.4 ± 17.5	81.5 ± 18.3	79.1 ± 23.9	51.1 ± 27.6
5 vs. 3	79.8 ± 14.7	75.9 ± 13.3	81.0 ± 14.4	71.8 ± 14.7	74.8 ±14.3	76.4 ± 12.3	75.9 ± 10.4	74.3 ± 13.1
Response time (s)		**				**		
2 vs. 1	0.97 ± 0.19	0.81 ± 0.22	0.85 ± 0.23	0.84 ± 0.31	0.93 ± 0.33	0.70 ± 0.17	0.86 ± 0.30	0.82 ± 0.23
3 vs. 1	1.10 ± 0.36	0.89 ± 0.33	0.99 ± 0.46	0.90 ± 0.40	1.11 ± 0.45	0.76 ± 0.25	0.83 ± 0.36	0.93 ± 0.44
3 vs. 2	1.38 ± 0.51	1.03 ± 0.43	1.00 ± 0.34	0.91 ± 0.33	1.28 ± 0.52	0.89 ± 0.39	1.02 ± 0.45	1.00 ± 0.42
4 vs. 3	1.50 ± 0.60	1.32 ± 0.55	1.31 ± 0.55	1.34 ± 0.64	1.51 ± 0.70	1.12 ± 0.41	1.19 ± 0.43	1.37 ± 0.49
5 vs. 3	1.40 ± 0.56	1.15 ± 0.55	1.15 ± 0.39	1.17 ± 0.54	1.51 ± 0.67	1.02 ± 0.49	1.05 ± 0.47	1.16 ± 0.55

Note: * denotes a significant difference from the control group ($p < 0.05$). ** denotes a significant difference from the tier one academy ($p < 0.05$).

Discussion

The current study examined the construct and discriminant validity of a video-based assessment for talent identification. The assessment showed some construct validity as developmental stage, the number of years playing soccer, and situation influenced decision-making performance. As hypothesised, the older players were faster at responding in each situation, when compared with their younger counterparts. However, response accuracy was similar across all developmental stages. The number of years playing soccer could explain the differences in decision-making performances between developmental stages. Decision-making performance also declined (i.e. lower response accuracy and slower response time) as situation complexity increased (i.e. a higher number of participating players and a closer attacker to defender ratio). Notably, the video-based decision-making assessment had limited discriminant validity in youth academy soccer players. While the assessment was able to discriminate youth academy soccer players from the control group using response accuracy, it lacked the sensitivity to determine inter-academy differences in decision-making performance. As a result, the current study's video-based decision-making assessment has limited applicability to talent identification.

The video-based decision-making assessment demonstrated two theoretical constructs. First, decision-making performance increased across developmental stages, with older players responding significantly faster than younger players in each situation. This was expected as response time naturally improves as the motor system develops (Thomas, Gallagher, & Purvis, 1981). Within the current study, it appeared that the improvements in decision-making performance were also associated with the number of years playing soccer. This was anticipated as increased exposure to soccer-related activities and position-specific training allows players to gain a greater understanding of the game and more efficiently process contextual information to determine the probability of certain events occurring (Berry, Abernethy, & Côté, 2008; Roca et al., 2012). Second, decision-making performance declined (i.e. response accuracy decreased and response time increased) with increasing situation complexity. From a theoretical standpoint, increasing the stimulus-response choices imposes greater processing demands on players as they are required to interpret more environmental stimuli prior to executing a response (Hick, 1952; Ripoll, Kerlirzin, Stein, & Reine, 1995). These increased processing demands coupled with a close attacker to defender ratio results in players requiring more time to determine the response action that would directly lead to a goal scoring opportunity.

The video-based decision-making assessment lacked discriminant validity and was unable to replicate previous research who used the same videos in a laboratory setting (Vaeyens et al., 2007b). While this finding was likely the result of the reduced specificity in the perception-action coupling (i.e. touching an iPad screen when compared with executing the actual soccer-specific skills), it highlights that video-based decision-making assessments cannot uniformly identify performance level differences in youth soccer players. Alternatively, the 'best' decision-makers in the current sample may be competing outside of the tier one academy, possibly due to selection biases (a tendency to favour physically advanced players) limiting their involvement in high-level talent development programs (REF). Importantly, other studies that use video-based decision-making assessments with non-specific response actions present limited evidence to support their employed methodological designs' construct validity (Keller et al., 2018b; O'Connor et al., 2016). This is concerning as they are often used in talent identification settings, where the proposed measures must represent a player's involvements during competitive match-play or at least be indicative of their potential to attain greater perceptual-cognitive expertise in the future.

Limitations

Inherently, there are several key limitations that confound the use of video-based decision-making assessments for talent identification purposes. Without the use of virtual reality, it is rather difficult to capture realistic viewing perspectives where players can explore the performance environment. The use of a third-person viewing perspective manipulates players' visual-search behaviours so that they focus on the free space available as opposed to the movements of their teammates and opposing players (Mann, Farrow, Shuttleworth, & Hopwood, 2009). Also, video-based assessments often remove key contextual information that influences the decision-making process (e.g. knowledge of teammates' soccer-specific skills, phase of play, coaches' tactical instructions, and score). Finally, removing the execution of a soccer-specific skill will decrease the assessments' task representativeness and likely conceal the perceptual-cognitive skills underlying superior decision-making performance (Travassos et al., 2013). Collectively, the data obtained from this assessment may only provide an indication of players' general perceptual-cognitive abilities rather than their specific perceptual-cognitive skills that are a characteristic of greater soccer expertise. Therefore, the use of video-based decision-making assessments – that are characterised by less realistic viewing perspectives or remove key contextual information – in talent identification is questionable.

Conclusion

Overall, the video-based decision-making assessment demonstrated some construct validity but lacked the sensitivity to determine inter-academy differences in decision-making performance. Developmental stage, the number of years playing soccer, and situation complexity all influenced decision-making performance. While the current study's assessment was developed to provide a practical measure of perceptual-cognitive and decision-making skills, the removal of a specific response action limited the usefulness of the assessment for talent identification purposes. Based on this study's findings, there is a clear need for future research to identify task representative perceptual-cognitive/decision-making assessments that possess both construct, discriminant, and practical validity for talent identification.

Practical implications

- Practical video-based decision-making assessments that use non-specific response actions lack the required validity for talent identification.

- A soccer player's perceptual-cognitive skills can likely only be measured using task representative assessments that replicate real-world perception-action couplings.

- Video-based decision-making assessments may play a role in the talent detection process where it is possible to direct youngsters from the general population who demonstrate favourable perceptual-cognitive abilities towards soccer.

Chapter six:

Study four

The confounding influences of sporting participation history on talent identification assessments in youth soccer

Under preparation for journal submission

Bennett, K.J.M., Pluss, M.A., Novak, A.R., Crowley-Mchatten, Z., Coutts, A.J., & Fransen, J. (Under Preparation). The confounding influences of sporting participation history on talent identification assessments in youth soccer.

"Study four focuses on mitigating a confounding factor in talent identification".

Abstract

The present study investigated the influences of sporting participation history on generic and sport-specific talent identification assessments in youth soccer. Male youth soccer players (n = 104, age = 13.8 ± 1.2 y) completed assessments of anthropometry, motor competence, and physical fitness. Players recorded their sporting participation history during the sampling years and were sub-divided into groups based on a medium split for their start age in competitive soccer (early and late), total volume of soccer-specific practice (low and high), total volume of peer-led play (low and high), number of other sports (few and many), and hours in other sports (low and high). Multivariate analysis of variance identified a significant effect for start age in competitive soccer ($p = 0.01$ and $\eta_p^2 = 0.11$), the total volume of soccer-specific practice ($p = 0.02$ and $\eta_p^2 = 0.09$), and the total volume of peer-led play ($p = 0.01$ and $\eta_p^2 = 0.10$) on motor competence. A significant effect was also identified for the number of other sports ($p = 0.04$ and $\eta_p^2 = 0.17$) on physical fitness. Overall, players with superior motor competence started soccer earlier, had a higher total volume of soccer-specific practice, and a higher total volume of peer-led play. Furthermore, players with greater physical fitness participated in less sports during development. This study supports the inclusion of sporting participation history as a confounder in the talent identification and development process due to its influences on a player's performance in generic and sport-specific assessments.

Keywords: football, talent selection, talent development, motor competence, physical fitness

Introduction

Talent identification – the process of identifying promising youth athletes who display the potential to develop future sporting excellence – is confounded by numerous factors that act on a cultural (e.g. coach education and participation rates), social-structural (e.g. available opportunities in academy programs and family support), and individual level (e.g. biological maturation and relative age effects) (Côté, 1999; Fraser-Thomas, Côté, & Deakin, 2008b; Hancock, Coutinho, Côté, & Mesquita, 2017; Rossing et al., 2018; Vaeyens et al., 2008; Williams & Reilly, 2000). Although researchers, national governing bodies, and sporting organisations require a thorough understanding of all confounders, an emphasis is usually placed on the factors that act on an individual level, as they are relatively easy to operationalise with single output measures (Augste & Lames, 2011; Johnson et al., 2017; Vandendriessche et al., 2012; Votteler & Höner, 2014). Indeed, coaches perceive early maturing and/or relatively older athletes as possessing greater long-term potential, which results in an over-representation of these athletes in high-level academy programs (Cripps et al., 2016; Furley & Memmert, 2016; Johnson et al., 2017). As such, later maturing and/or relatively younger athletes often receive less developmental opportunities and require exceptional performances to even be considered as 'talented' (Zuber et al., 2016). Generally, the impact of advanced biological maturation and an older relative age on talent identification is well documented (Sarmento et al., 2018). However, the effect of other social-structural confounders such as an athlete's sporting participation history have on the talent identification process still eludes sporting professionals and researchers, as these confounders often have multiple interacting components that are difficult to holistically measure.

Although sporting participation history is typically considered in talent development discussions, it does not seem to be as prevalent when evaluating talent identification practices. One popular model that associates sports participation with the development of excellence is the Developmental Model of Sports Participation (Côté, 1999; Côté et al., 2003, 2007; Côté & Fraser-Thomas, 2007). The Developmental Model of Sports Participation describes two pathways towards expert performance: early specialisation and early diversification. Early specialisation involves participating in a single sport from an early age and often encompasses a high volume of deliberate practice (i.e. goal-direct activities that require continual physical and cognitive effort) where the main aim is to improve performance (Ericsson et al., 1993). In contrast, early diversification involves sampling multiple sports during the formative years (i.e. sampling stage: 6 – 12 years) to broaden motor competence and learning experiences (Côté et al., 2009b) and is associated with a high volume of deliberate play (i.e. modified sports games performed with the goal of maximising enjoyment) (Côté et al., 2003). Following the age of 12, athletes gradually reduce their participation in other sports and playful activities and focus on improving performance in their main sport primarily through deliberate practice.

While the Developmental Model of Sports Participation is relevant in understanding the pathways related to sporting excellence, it also holds vital information on the potential confounding effect of sporting participation history in the talent identification process. For example, it is common in talent identification research to include multiple generic and sport-specific assessments of anthropometry, motor competence, physical fitness, decision-making, and technical skills (Coelho-e-Silva et al., 2010; Deprez et al., 2015b; Huijgen et al., 2014; O'Connor et al., 2016; Vaeyens et al., 2006), yet the extent to which these measures vary according to players' sporting participation history remains under-researched. To allow researchers, coaches, and sporting professionals to critically evaluate the role of sporting participation history in talent identification, it is necessary to retrospectively assess expert athletes' sporting participation history. Several studies have attempted to relate soccer excellence with retrospective differences in sporting participation history. Professional players begin participating in soccer from an early age through informal play activities (Ford et al., 2009; Ford & Williams, 2012; Hendry & Hodges, 2018) and are involved in other sports throughout their development (Hornig et al., 2016). While many of these professional players perform a large amount of deliberate play during their formative years, they are still able to accumulate a significant volume of deliberate practice (Ford et al., 2009; Hendry & Hodges, 2018; Hornig et al., 2016). It seems that a unique interaction exists between the amount of deliberate practice (i.e. soccer-specific training) and deliberate play (i.e. informal peer-led play), where professional players accumulate a higher than average volume in each category (Sieghartsleitner et al., 2018).

These findings highlight some of the developmental processes associated with future excellence in soccer, however it remains unclear how they inform talent identification. Therefore, the present study aimed to investigate if individual components of youth academy soccer players' sporting participation history (start age in competitive soccer, total volume of soccer-specific practice, total volume of peer-led play, number of other sports, and hours in other sports) influenced their performance on generic and sport-specific talent identification assessments (motor competence and physical fitness). It was hypothesised that superior performances in a generic motor competence assessment would be associated with sampling multiple sports during development and more peer-led play hours. It was also hypothesised that superior performances in sport-specific physical fitness assessments would be associated with less other sport participation and more soccer-specific practice.

Methods

Participants

The sample consisted of 104 male youth soccer players aged 12.0 to 15.9 y (age = 13.8 ± 1.2 y) from two-member federations (Northern NSW Football and Football NSW) within Australia. Players were registered with several youth academy development programs, which were involved in state-based National Premier League and Association Youth League competitions. Each respective development program provided players with a minimum of 40 weeks of soccer-specific training across the year. Any player who was injured or unable to complete bouts of high-intensity activity was excluded from the study. All players and their parents/legal guardians were informed of the aims and the requirements of the research. Players were advised that participation was voluntary and would not impact on their position or future selection within the academy. The Institutional Ethics Research Committee approved this study (ETH16-0634).

Experimental procedures

Anthropometry, biological maturity, motor competence, and physical fitness assessments were conducted during a player's normal training session. All assessments were performed in a strict order with sufficient recovery time (1. Anthropometry, 2. Motor competence, and 3. Physical fitness). Players undertook a dynamic warm up consisting of muscular activation and mobilisation drills, sprinting builds, and acceleration/deceleration preparation before commencing any physical assessment. Players were provided with a four-week period (i.e. two weeks before and after testing) to record their sporting participation history.

Anthropometry

A university-trained sporting professional recorded players' stature (seca 217, seca, Germany), sitting height (Harpenden Sitting Height Table, Holtain, United Kingdom), and body mass (kg, BF-522 Body Fat/Body Water Analyzer, Tanita, Japan). Players' leg length was calculated as the difference between stature and sitting height. Test-retest reliability and measurement accuracy was examined using a subset of 59 players. The intraclass correlation coefficient for stature was 1.00 with a mean difference of < 0.1 cm between measures. For sitting height, the intraclass correlation coefficient and mean difference was 1.00 and 0.3 cm, respectively.

Biological maturity

Maturity ratio was estimated using the maturity ratio equation (Fransen et al., 2018), which was developed using the original sample of Canadian children (Mirwald, Baxter-Jones, & Bailey, 2002) and cross-validated in high-level Belgian youth soccer players. Age at peak height velocity was expressed as a player's chronological age relative to their maturity ratio.

Motor competence

Overall gross motor coordination (i.e. dynamic balancing ability, object manipulation, and lateral jumping) was estimated using three subtests of the KTK: balancing backwards, moving sideways, and jumping sideways. All subtests were conducted according to the test manual (Kiphard & Schilling, 1974, 2007). The shortened version of the KTK shows substantial agreement with the original version in a sample of 6 to 14-year-old children (Novak et al., 2017).

Physical fitness

The current study assessed four aspects of physical fitness: lower body muscular power, linear sprint speed, change of direction skill, and intermittent aerobic endurance. To assess lower body muscular power, players completed a vertical jump assessment (Vertec, Swift Performance Equipment, Australia). Players were instructed to stand with their dominant arm fully extended above their head and displace the highest rotating vane that they could reach without lifting their heels off the ground (i.e. standing height). Players then performed two countermovement jumps with no restrictions touching the highest rotating vane they could reach (i.e. jump height). The greatest difference between players' standing and jump height was recorded as their final score. Players' maximal linear sprint speed was assessed over a 30 m distance, with 5 and 30 m split times recorded using a telemetric electronic timing system (SmartSpeed Pro, Fusion Sport, Australia). Sprints were completed from a standing start, 0.5 m behind the first timing gate with the best 5 and 30 m splits from two trials recorded. Change of direction skill was quantified using a modified t-test described in Deprez et al. (2015a). Two assessors recorded split times using hand-held stopwatches. To maintain consistency, the assessors commenced timing when the player lifted their heel off the ground and ceased timing when the first part of the players' body passed through the virtual gate. The average time between assessors was recorded for each direction. The intraclass correlation coefficient for change of direction skill was 0.96 with a mean difference of -0.01 s between measures. Players' intermittent aerobic endurance was determined using the established Yo-Yo Intermittent Recovery Test – Level 1 protocol and expressed as the total distance covered (Krustrup et al., 2003).

Sporting participation history

Players, with the assistance of their parents or legal guardians, completed an online version of the participation history questionnaire (Appendix 8). This questionnaire is reported as a valid and reliable method of collecting participation history data (Ford, Low, McRobert, & Williams, 2010; Ward et al., 2007). The questionnaire was used to elicit information on players' soccer-specific milestones (start age in competitive soccer), engagement in soccer-related activities (total volume of soccer-specific practice and peer-led play), and engagement in other sporting activities (number of other sports and total hours in other sports). Given the focus of the current study, activities that occurred prior to the age of 12 were retained for analyses. Data from the questionnaire were categorised into dichotomous variables using a median split: (1) start age in competitive soccer (early = 4.9 ± 0.4 y, and late = 7.9 ± 2.0 y), (2) total volume of soccer-specific practice (low = 585.0 ± 270.5 h, and high = 1778.1 ± 963.8 h), (3) total volume of peer-led play (low = 254.3 ± 203.3 h, and high = 1297.2 ± 683.0 h), (4) number of other sports (few = 2 ± 1, and many = 5 ± 2), and (5) hours in other sports (low = 151.7 ± 141.8 h, and high = 1129.6 ± 673.0 h).

Statistical analysis

A Kolmogorov-Smirnov test and visual inspection of the Q-Q plots and histograms were used to assess the assumptions of normality. Descriptive statistics were calculated for all variables and presented as mean ± SD. Dependent variables were sub-divided into motor competence (total points in balancing backwards, moving sideways, and jumping sideways) and physical fitness (vertical jump height, 5 m sprint time, 30 m sprint time, t-test time, and Yo-Yo distance covered). Anthropometry (age at peak height velocity, stature, and body mass) was included as a control variable in the analyses and was not a main outcome for the current study. Due to the multifactorial nature of this study, the sample size varied for each analysis as some players had missing data. Multivariate analysis of variance investigated the influence of start age in competitive soccer, total volume of soccer-specific practice, total volume of peer-led play, number of other sports, and hours in other sports on anthropometry, motor competence, and physical fitness. Bonferroni *post-hoc* corrections were applied to allow for multiple comparisons and to determine individual differences. A criterion alpha level of significance was set at $p < 0.05$. Partial Eta Squared effect sizes were evaluated as *small* = 0.01, *moderate* = 0.06 and *strong* = 0.14 (Cohen, 1988). All statistical analyses were conducted using SPSS software (Version 25.0, IBM Corporation, United States of America).

Results

Start age in competitive soccer

No significant multivariate effects were evident for start age in competitive soccer on anthropometry (F = 0.14, $p = 0.94$, $\eta_p^2 < 0.01$) or physical fitness (F = 0.22, $p = 0.95$, $\eta_p^2 = 0.02$). No significant univariate effects were identified for any anthropometry or physical fitness measure (Table 6.1). There was a significant *moderate* multivariate effect for start age in competitive soccer on motor competence (F = 4.17, $p = 0.01$, $\eta_p^2 = 0.11$). Significant univariate effects were identified for moving sideways and jumping sideways scores. Players who began competitive soccer at an earlier age scored on average 5.4 points better for moving sideways and 6.1 points better for jumping sideways, when compared with those players who started later.

Table 6.1. The effect of start age in competitive soccer (early or late) on youth soccer players' anthropometry, motor competence, and physical fitness (mean ± SD).

	Start age in competitive soccer				
Performance characteristic	**Early**	**Late**	**F**	***p***	η_p^2
Anthropometry	*n* = 61	*n* = 43			
Age at peak height velocity (y)	13.9 ± 0.6	13.9 ± 0.7	0.13	0.72	< 0.01
Stature (cm)	161.7 ± 11.7	161.6 ± 9.9	0.00	0.99	< 0.01
Body mass (kg)	50.3 ± 11.5	49.6 ± 9.9	0.89	0.77	< 0.01
Motor competence	*n* = 59	*n* = 42			
Balancing backwards (points)	56.3 ± 10.0	55.5 ± 9.9	0.15	0.70	< 0.01
Moving sideways (points)	62.1 ± 7.4*	56.7 ± 9.2	10.60	0.00	0.10
Jumping sideways (points)	96.9 ± 10.3*	90.8 ± 12.1	7.34	0.01	0.07
Physical fitness	*n* = 44	*n* = 22			
Vertical jump (cm)	47.1 ± 8.4	45.5 ± 6.8	0.59	0.44	0.01
5 m sprint (s)	1.10 ± 0.09	1.10 ± 0.09	0.03	0.86	< 0.01
30 m sprint (s)	4.71 ± 0.36	4.75 ± 0.33	0.23	0.64	< 0.01
T-test (s)	8.15 ± 0.42	8.23 ± 0.33	0.57	0.45	0.01
Yo-Yo (m)	1202 ± 514	1096 ± 426	0.70	0.41	0.01

Note: * denotes a significant ($p < 0.05$) univariate effect.

Total volume of soccer-specific practice hours

No significant multivariate effects were evident for the total volume of soccer-specific practice on anthropometry (F = 2.32, $p = 0.08$, $\eta_p^2 = 0.07$). However, a significant univariate effect was identified for stature and body mass (Table 6.2). Players who completed a greater volume of soccer-specific practice were 5.5 cm shorter and 4.7 kg lighter than players who completed a lower volume of soccer-specific practice. A significant *moderate* multivariate effect was evident for total volume of soccer-specific practice on motor competence (F = 3.31, $p = 0.02$, $\eta_p^2 = 0.09$). Significant univariate effects were identified for balancing backwards score. Players who completed more soccer-specific practice scored 6.2 points better on balancing backwards when compared with players who completed less soccer-specific practice. No significant multivariate effects were evident for total volume of soccer-specific practice on physical fitness (F = 0.52, p = 0.76, η_p^2 = 0.04). No significant univariate effects were identified for any physical fitness measures.

Table 6.2. The effect of the total volume of soccer-specific practice (low and high) on youth soccer players' anthropometry, motor competence, and physical fitness (mean ± SD).

	Total volume of soccer-specific practice				
Performance characteristic	**Low**	**High**	**F**	***p***	**η_p^2**
Anthropometry	*n* = 52	*n* = 52			
Age at peak height velocity (y)	13.8 ± 0.7	14.0 ± 0.6	2.13	0.15	0.02
Stature (cm)	164.4 ± 10.2*	158.9 ± 11.0	7.06	0.01	0.07
Body mass (kg)	52.4 ± 10.6*	47.7 ± 11.0	5.02	0.03	0.05
Motor competence	*n* = 51	*n* = 50			
Balancing backwards (points)	53.2 ± 10.1	58.8 ± 8.9*	8.97	0.00	0.08
Moving sideways (points)	59.2 ± 9.5	60.5 ± 7.5	0.55	0.46	< 0.01
Jumping sideways (points)	92.5 ± 9.5	96.3 ± 13.0	2.85	0.09	0.03
Physical fitness	*n* = 30	*n* = 36			
Vertical jump (cm)	46.4 ± 8.1	46.6 ± 7.8	0.02	0.89	< 0.01
5 m sprint (s)	1.09 ± 0.08	1.11 ± 0.09	0.43	0.51	0.01
30 m sprint (s)	4.71 ± 0.35	4.73 ± 0.36	0.08	0.77	< 0.01
T-test (s)	8.23 ± 0.42	8.14 ± 0.37	0.96	0.33	0.02
Yo-Yo (m)	1163 ± 520	1171 ± 464	0.01	0.95	< 0.01

Note: * denotes a significant ($p < 0.05$) univariate effect.

Total volume of peer-led play hours

No significant multivariate effects were evident for the total volume of peer-led play on anthropometry (F = 0.31, *p* = 0.82, η_p^2 = 0.01). No significant univariate effects were identified for any anthropometry measures (Table 6.3). A significant *moderate* multivariate effect was evident for the total volume of peer-led play on motor competence

(F = 3.76, p = 0.01, η_p^2 = 0.10). Significant univariate effects were identified for balancing backwards score. Players who completed a greater volume of peer-led play scored 6.2 more points on balancing backwards then those who had completed a lower volume. No significant multivariate effects were evident for the total volume of peer-led play on physical fitness (F = 1.41, p = 0.23, η_p^2 = 0.11). However, a significant univariate effect was identified for Yo-Yo distance covered. On average, players who completed a greater volume of peer-led play covered 245 m more during the Yo-Yo when compared with those who completed less hours of peer-led play.

Table 6.3. The effect of the total volume of peer-led play (low and high) on youth soccer players' anthropometry, motor competence, and physical fitness (mean ± SD).

	Total volume of peer-led play				
Performance characteristic	**Low**	**High**	**F**	***p***	**η_p^2**
Anthropometry	n = 52	n = 52			
Age at peak height velocity (y)	13.9 ± 0.7	13.9 ± 0.6	0.01	0.92	< 0.01
Stature (cm)	162.1 ± 10.3	161.3 ± 11.6	0.13	0.72	< 0.01
Body mass (kg)	50.8 ± 10.7	49.3 ± 11.1	0.52	0.47	0.01
Motor competence	n = 50	n = 51			
Balancing backwards (points)	52.9 ± 10.0	59.0 ± 8.8*	10.86	0.00	0.10
Moving sideways (points)	58.5 ± 7.8	61.1 ± 9.1	2.33	0.13	0.02
Jumping sideways (points)	92.4 ± 9.2	96.3 ± 13.0	3.08	0.08	0.03
Physical fitness	n = 33	n = 33			
Vertical jump (cm)	46.3 ± 7.0	46.7 ± 8.8	0.04	0.85	< 0.01
5 m sprint (s)	1.11 ± 0.09	1.09 ± 0.09	1.03	0.31	0.02
30 m sprint (s)	4.77 ± 0.36	4.67 ± 0.33	1.41	0.24	0.02
T-test (s)	8.26 ± 0.35	8.10 ± 0.39	2.69	0.11	0.04
Yo-Yo (m)	1045 ± 433	1290 ± 511*	4.41	0.04	0.06

Note: * denotes a significant (p < 0.05) univariate effect.

Number of other sports

No multivariate effects were evident for the number of other sports on anthropometry (F = 1.52, p = 0.21, η_p^2 = 0.04) or motor competence (F = 0.08, p = 0.97, η_p^2 < 0.01). No significant univariate effects were identified for any anthropometry or motor competence measures (Table 6.4). A *strong* multivariate effect was evident for the number of other sports on physical fitness (F = 2.50, p = 0.04, η_p^2 = 0.17). Significant univariate effects were identified for 5 and 30 m sprint times. Players who participated in fewer other sports during development were 0.06 and 0.17 s faster over 5 and 30 m when compared with players who participated in more sports, respectively.

Table 6.4. The effect of the number of other sports (few and many) on youth soccer players' anthropometry, motor competence, and physical fitness (mean ± SD).

	Number of other sports				
Performance characteristic	**Low**	**High**	**F**	***p***	**η_p^2**
Anthropometry	*n* = 51	*n* = 53			
Age at peak height velocity (y)	13.8 ± 0.7	13.9 ± 0.6	1.72	0.19	0.02
Stature (cm)	163.0 ± 11.1	160.4 ± 10.7	1.50	0.22	0.01
Body mass (kg)	52.1 ± 12.0	48.0 ± 9.3	3.67	0.06	0.04
Motor competence	*n* = 50	*n* = 51			
Balancing backwards (points)	56.2 ± 9.4	55.8 ± 10.4	0.03	0.86	< 0.01
Moving sideways (points)	60.1 ± 8.1	59.5 ± 9.1	0.12	0.73	< 0.01
Jumping sideways (points)	94.3 ± 12.4	94.4 ± 10.5	0.00	0.96	< 0.01
Physical fitness	*n* = 31	*n* = 35			
Vertical jump (cm)	47.8 ± 8.1	45.4 ± 7.7	1.50	0.23	0.02
5 m sprint (s)	1.06 ± 0.10*	1.13 ± 0.07	8.83	0.04	0.12
30 m sprint (s)	4.63 ± 0.41*	4.80 ± 0.27	4.19	0.05	0.06
T-test (s)	8.18 ± 0.41	8.18 ± 0.39	0.01	0.93	< 0.01
Yo-Yo (m)	1156 ± 509	1177 ± 472	0.03	0.86	< 0.01

Note: * denotes a significant (p < 0.05) univariate effect.

Total hours in other sports

No multivariate effects were evident for the total hours in other sports on anthropometry (F = 1.06, p = 0.37, η_p^2 = 0.03), motor competence (F = 0.50, p = 0.68, η_p^2 = 0.02), or physical fitness (F = 0.54, p = 0.75, η_p^2 = 0.04). No significant univariate effects were identified for any of the dependent variables (Table 6.5).

Table 6.5. The effect of the total hours in other sports (low and high) on youth soccer players' anthropometry, motor competence, physical fitness (mean ± SD).

	Total hours in other sports				
Performance characteristic	**Low**	**High**	**F**	***p***	**η_p^2**
Anthropometry	*n* = 52	*n* = 52			
Age at peak height velocity (y)	13.9 ± 0.7	13.9 ± 0.6	0.00	0.97	< 0.01
Stature (cm)	163.1 ± 11.2	160.2 ± 10.5	1.81	0.18	0.02
Body mass (kg)	50.8 ± 11.5	49.2 ± 10.1	0.53	0.47	0.01
Motor competence	*n* = 50	*n* = 51			
Balancing backwards (points)	56.9 ± 9.0	55.1 ± 10.7	0.90	0.35	0.01
Moving sideways (points)	60.7 ± 8.0	59.0 ± 9.0	0.95	0.33	0.01
Jumping sideways (points)	94.8 ± 10.9	93.9 ± 12.0	0.16	0.69	< 0.01
Physical fitness	*n* = 31	*n* = 35			
Vertical jump (cm)	47.1 ± 7.9	46.0 ± 7.9	0.35	0.56	0.01
5 m sprint (s)	1.08 ± 0.08	1.12 ± 0.10	1.94	0.17	0.03
30 m sprint (s)	4.66 ± 0.34	4.78 ± 0.35	2.08	0.15	0.03
T-test (s)	8.14 ± 0.35	8.21 ± 0.43	0.55	0.46	0.01
Yo-Yo (m)	1164 ± 431	1170 ± 536	0.00	0.96	< 0.01

Note: * denotes a significant (p < 0.05) univariate effect.

Discussion

Several key aspects of youth soccer players' sporting participation history are associated with their anthropometry, motor competence, and physical fitness. In support of the current study's hypothesis, a greater total volume of peer-led play was associated with superior motor competence. However, both an earlier start age in competitive soccer and completing a greater total volume of soccer-specific practice were also linked with superior motor competence. The second hypothesis was partially evident in the current data, with less participation in other sports associated with superior physical fitness. Notably, a greater volume of peer-led play was also related to superior physical fitness.

The present results show that an earlier start age in competitive soccer, a greater total volume of soccer-specific practice, and more peer-led play are associated with superior motor competence. These results agree with several studies who linked prolonged sporting participation with superior motor competence (Henrique et al., 2016; Vandorpe et al., 2012). In the case of the current study, the earlier start age in competitive soccer provided players with greater exposure to both structured (i.e. soccer-specific practice) and unstructured (i.e. peer-led play) activities. It is suggested that structured and unstructured activities are beneficial for the development of motor competence. From a skill acquisition perspective, involvement in unstructured activities like peer-led play present players with different action sequences and situational contexts (Côté et al., 2007; Davids, Button, & Bennett, 2008). As these play-based activities are largely implicitly driven and players must self-discover their own movement solutions to the task constraints, it is likely that it develops greater movement diversity and assists with improving players' motor competence (Côté et al., 2003).

An unexpected finding of the current study was the limited association between early sports sampling and superior motor competence. Early sports sampling exposes players to a range of movement problems and is commonly suggested to benefit youth development (Côté et al., 2009a; Côté et al., 2009b). A possible explanation for the current finding is that the benefits of early sports sampling may not be directly observed in the form of higher motor competence, but as a higher potential to possess greater soccer-specific skills later in development (Vandorpe et al., 2012) or improve match-play performance (Güllich, Kovar, Zart, & Reimann, 2017). An alternative explanation is that early sports sampling creates a protective effect through reducing the chances of a player dropping out (Fraser-Thomas, Côté, & Deakin, 2008a) or increasing their intrinsic motivation towards continuing participation in a sport (Côté et al., 2009a; Ryan & Deci, 2000). Although the direct benefits of early sports sampling were not clear within this study, it is important to consider how this variable was created. Players were sub-divided into two groups based on a median split: players who participated in relatively few or relatively many other sports than soccer. As such, players in the relatively few group still participated in other sports during development (between 0 and 3 other sports). The potential benefits of even a small number of other sports may have mitigated any group differences in motor competence.

The current results also indicated that less participation in other sports and a greater total volume of peer-led play was related to superior physical fitness (i.e. linear sprint speed and intermittent cardiovascular endurance). The relationship between less participation in other sports and superior fitness opposes previous findings, who reported superior fitness (i.e. lower body muscular power, speed, and agility) in boys (aged 10 – 12 y) who sampled more than one sport during development (Fransen et al., 2012). The lack of agreement in the findings may result from demographic differences. The population in this study was a sport-specific sample of youth soccer players, whereas Fransen et al. (2012) utilised a more general sample of children from different sports and physical education programs in schools. It is well established that high-level academies favour youth soccer players who possess superiorities in physical fitness (Coelho-e-Silva et al., 2010; Figueiredo et al., 2009a; Vaeyens et al., 2006) as they are perceived to possess greater long-term potential (Cripps et al., 2016; Furley & Memmert, 2016). As such, a selection bias may have confounded this study's findings. In addition, the somewhat unexpected finding of an association between a greater total volume of peer-led play and greater physical fitness remains unresolved. It is possible that the unstructured nature of peer-led play creates an environment that imposes greater running demands which in turn stimulates the development of physical attributes. However, future research is needed to support this hypothesis as retrospective analyses alone cannot determine causality.

Together, these findings have important implications for talent identification practice. Coaches and sporting professionals are encouraged to interpret players' performances on generic and sport-specific talent identification assessments relative to their sporting participation history to create equal opportunities for players with different developmental backgrounds. Based on the current study's findings, superior motor competence and physical fitness were related to three (an earlier start age in competitive soccer, a greater total volume of soccer-specific practice, and a greater total volume of peer-led play) and two (less participation in other sports and a greater total volume of peer-led play) components of sporting participation history, respectively. Including sporting participation history measures in talent identification will help to minimise any short-term benefits certain developmental pathways might have on motor competence and physical fitness. For example, a player's superior fitness during the initial stages of talent identification may be the result of minimal participation in other sports, which allowed the player to benefit from a longer period of soccer-specific training. In comparison, a player's poor physical fitness may have resulted from a lack of soccer-specific training, due to participating in multiple other sports during development. However, this player may indirectly benefit from their engagement in other sports during later stages of development, where the performance benefits of participation in multiple other sports may become more apparent.

Limitations

The current study's findings provide further insight into the confounding influences of sporting participation history on generic and sport-specific talent identification assessments. When interpreting these findings, there are some limitations to consider. First, these data are only a cross-sectional representation of a specific cohort of youth soccer players. Therefore, it is only possible to associate individual components of sporting participation history with players' performance in the assessments and hence causality cannot be determined. Longitudinal data will improve the understanding of the specific contribution of players' sporting participation history on their talent identification assessment performance. Second, the current study only analysed the impact of sporting participation history on talent identification assessment performance using quantitative data. As such, future research is needed to address the limited information surrounding qualitative sporting participation history data. Third, youth soccer players' sporting participation history was collected using a retrospective questionnaire. Although this method of collecting data demonstrates sufficient reliability and validity, retrospective recall bias usually results in players overestimating the activities that occurred more recently and underestimating the activities that occurred earlier in development (Howard, 2011; Kemp, 1988). Inherently, this limits the causal interpretation of these data. Finally, the present study focused on the impact of players' sporting participation history during the sampling years on measures of motor competence and physical fitness. As performance data was collected when players were aged between 12.0 and 15.9 y, it is possible that the activities older players completed following the sampling years influenced the observed results

Conclusion

This study supports the inclusion of sporting participation history as a confounder in the talent identification and development process due to its potential influences on a player's performance in talent identification assessments. Superior motor competence was linked with an earlier start age in competitive soccer, a greater total volume of soccer-specific practice, and more peer-led play. Whereas, superior physical fitness was associated with more peer-led play and less participation in other sports. Therefore, to minimise any short-term performance of certain developmental activities, coaches and sporting professionals should interpret players' talent identification assessment performance relative to their sporting participation history. Further research should longitudinally track players' developmental activities and sporting participation during development to allow for a stronger causal interpretation of such data.

Practical implications

As part of a practical guide for talent identification and development, it is necessary to implement strategies at a cultural, social-structural, and individual level. On a cultural level, governing bodies must educate coaches and sporting professionals on the confounding influences of sporting participation history and the potential advantages and/or disadvantages of certain developmental pathways. At a social-structural level, sporting organisations should develop and maintain a central repository that concurrently tracks players' sporting participation data. Creating a central repository will help to minimise the recall bias associated with retrospective questionnaires and allow for greater depth of analyses. Depending on the available resources, the following data can be tracked on a weekly, monthly, or yearly basis: the hours of soccer-specific practice, the hours of peer-led play, and the hours in other sports. Where possible, it is also beneficial to track the amount of deliberate practice and play in other sports. Integrating this process across multiple sporting organisations will further streamline this process. Finally, concurrently collecting sporting participation history will allow coaches and sporting professionals to interpret the individual impact on talent identification and development. Combining these measures of sporting participation history with other individual confounders such as biological maturation and relative age effects will help to minimise selection biases.

Chapter seven:

Study five

A multifactorial comparison of youth soccer players' performance characteristics

Under preparation for journal submission

Bennett, K.J.M., Novak, A.R., Pluss, M.A., Coutts, A.J., & Fransen, J. A multifactorial comparison of youth soccer players' performance characteristics.

"Study five provides an insight into the Australian youth soccer system and details the playing level differences that exist".

Abstract

The aim of the current study was to investigate the performance characteristics that discriminate youth soccer players according to their academy status (tier one and tier two). A total of 74 Australian male youth soccer players participated in this study. Players were sub-divided into two age groups: early adolescence (*n* = 43, age = 13.0 ± 0.6 y) and mid-adolescence (*n* = 31, age = 15.0 ± 0.6 y). A multifactorial study design was employed containing measures of anthropometry, motor competence, physical fitness, decision-making, and psychological traits. A stepwise discriminant analysis identified body mass, dynamic balancing ability, linear sprint speed over 5 m, and change of direction skill as significant predictors of tier one academy status in the early adolescence group. This discriminant function yielded a 76.9% classification accuracy. A second stepwise discriminant analysis identified dynamic balancing ability, linear sprint speed over 5 m, 3 vs. 1 response accuracy, and 3 vs. 1 response time as significant predictors of tier one academy status in the mid-adolescence group. This discriminant function yielded an 85.2% classification accuracy. Overall, performance in the motor competence (i.e. dynamic balancing ability) and physical fitness (i.e. 5 m sprint and t-test) assessments were in favour of the tier one academy players. Whereas, the one component of decision-making assessment (i.e. 3 vs. 1 accuracy and response time) was in favour of the tier two players. Collectively, these findings allude to a potential selection bias within the Australian talent pool. However, future research is required to further substantiate this in a larger sample of youth soccer players from other playing regions within Australia.

Keywords: football, talent selection, talent development, motor competence, physical fitness

Introduction

Talent identification and development in soccer is a complex and multifaceted process that involves numerous stakeholders which govern, but also implement strategies to assist promising youth players in their pursuit of future success (Vaeyens et al., 2008). Most of the recent research in talent identification and development examines the key characteristics of talented players – including their anthropometry, physical fitness, soccer-specific skills, perceptual-cognitive skills, and psychological traits – that likely contribute to the attainment of soccer expertise (Gledhill et al., 2017; Sarmento et al., 2018). Notably, longitudinal and retrospective analyses of senior professional players associate their performance characteristics during adolescence with their current level of soccer expertise. Indeed, professional senior players demonstrate superior physical fitness, soccer-specific skills, and perceptual-cognitive skills during adolescence when compared with non-professionals. Specifically, these superiorities include: linear sprint speed, lower body muscular power, intermittent aerobic endurance, dribbling, ball control, shooting, positioning, and decision-making (Deprez et al., 2015b; Emmonds et al., 2016; Höner et al., 2017; Huijgen et al., 2009; Kannekens, Elferink-Gemser, & Visscher, 2011).

Most of these observational studies are completed in established football nations (e.g. Belgium, Germany, and England), which have highly structured talent pathways and large talent pools with high soccer participation rates, substantial financial and logistical support, and a strong domestic competition (study one). In comparison, emerging football nations (e.g. Australia, Iceland, and Panama) have less established talent pathways and smaller relative talent pools with lower soccer participation rates, less financial and logistical resources, and a weaker domestic competition. While all football nations exist somewhere on a continuum between emerging and established, it is difficult to substantiate whether the current approaches more established football nations' use for talent identification and development would be as effective in emerging football nations. As such, it is essential to further investigate emerging football nations' current talent identification and development programs.

To date, few studies have comprehensively examined the talent identification and development programs used in emerging football nations (Keller et al., 2016, 2018a; Keller et al., 2018b; Lovell et al., 2018; O'Connor et al., 2016). One emerging football nation that has recently received more attention in talent identification and development research is Australia. Within Australia, the governing body (FFA) has created the 'Whole of Football Plan' and the 'National Football Curriculum' to assist with streamlining the pathway for promising youth players and defining the environment required for developing soccer success (Football Federation Australia, 2014, 2015). A key problem recognised in the 'National Football Curriculum' is the overreliance on physically gifted soccer players as opposed to those who are technically and tactically gifted. Current research in Australian soccer presents similar data to that collected in established football nations, with high-level players showing superiorities in most of their performance characteristics. Generally, high-level players (15 – 17 years old) are taller, possess greater linear sprint speed, have a higher intermittent aerobic endurance capacity, better soccer-specific skills, and superior decision-making skills, when compared with those competing at lower levels (Keller et al., 2016, 2018a; Keller et al., 2018b; O'Connor et al., 2016).

Although this information provides an insight into the performance characteristics of older youth soccer players, determining whether these playing level differences extend to younger age groups will prove valuable for talent identification and development practice. It is suggested that selection biases within playing levels can significantly affect the size and depth of the talent pool (study one). Therefore, the purpose of the current study was to implement a multifactorial design to determine if early and mid-adolescent high-level (i.e. tier one academy) youth soccer players exhibited superior performance characteristics (i.e. anthropometry, motor competence, physical fitness, decision-making, and psychological traits) when compared with those competing at lower levels (i.e. tier two academy). Using current talent identification and development data, it was hypothesised that the following performance characteristics would discriminate playing levels: (1) advanced anthropometry and superior physical fitness (Figueiredo et al., 2009a); (2) superior motor competence (Deprez et al., 2015b; Vandorpe et al., 2011); (3) greater response accuracy and faster response times in a video-based decision-making assessment (Keller et al., 2018b; O'Connor et al., 2016; Vaeyens et al., 2007a); and (4) a higher task than ego orientation (Höner & Feichtinger, 2016; Zuber et al., 2015).

Methods

Participants

A total of 74 Australian male youth soccer players from two age groups (early adolescence: n = 43, age = 13.0 ± 0.6 y, and mid-adolescence: n = 31 age = 15.0 ± 0.6 y) participated in the current study. Players were sub-divided into playing levels based on their academy. The tier one academy (n = 45, age = 13.8 ± 1.2 y) contained players who were competing at the top-level for their age-group and were part of a Hyundai A-League club development program. An internationally accredited technical director (i.e. Asian Football Confederation A Licence and UEFA B Licence) supervised this academy's development program. Players completed approximately 12 h of coach-led technical and tactical practice per fortnight (i.e. 8 × 1.5 h sessions) throughout the 48-week season. The tier two academy (n = 29, age = 14.0 ± 1.0 y) contained players who were part of a National Premier League development program. A nationally accredited technical director (i.e. FFA C Licence) supervised this academy's development program. Players trained during 41 weeks of the year and completed approximately 7.5 h of coach-led technical and tactical practice per fortnight during the competition phase of the season (i.e. 5 × 1.5 h sessions) and 6.0 h during the pre-season (i.e. 4 × 1.5 h sessions). Players who were injured or unable to participate in bouts of high-intensity activity at the time of testing were excluded from the study. All players and their parents/legal guardians were informed of the aims and the requirements of this research. The Institutional Ethics Research Committee approved this study (ETH16-0634).

Experimental procedures

Anthropometry, biological maturity, motor competence, physical fitness, decision-making, and psychological traits assessments were conducted during a player's normal training session. All assessments were performed in a strict order with sufficient recovery time (1. Psychological traits, 2. Decision-making, 3. Anthropometry, 4. Motor competence, and 5. Physical fitness). Players undertook a dynamic warm up consisting of muscular activation and mobilisation drills, sprinting builds, and acceleration/deceleration preparation before commencing any physical assessment.

Anthropometry

A university trained sporting professional recorded players' stature (seca 217, seca, Germany), sitting height (Harpenden Sitting Height Table, Holtain, United Kingdom), and body mass (BF-522 Body Fat/Body Water Analyzer, Tanita, Japan). Leg length was calculated as the difference between stature and sitting height. Test-retest reliability and measurement accuracy of stature and sitting height measures were examined using a sub-test of 43 players. The ICC for stature was 1.00 with a mean difference of -0.01 cm between measures. The ICC for sitting height was 1.00 with a mean difference of 0.14 cm between measures. A maturity ratio equation estimated biological maturity (Fransen et al., 2018). Players' age at peak height velocity was calculated using their chronological age relative to their maturity ratio.

Motor competence

Overall gross motor coordination (i.e. dynamic balancing ability, object manipulation, and lateral jumping) was estimated using three subtests of the KTK (i.e. balancing backwards, moving sideways, and jumping sideways) according to the test manual (Kiphard & Schilling, 1974, 2007). The modified and original version of the KTK shows substantial agreement in 6 to 14-year-old children (Novak et al., 2017).

Physical fitness

The current study assessed lower body muscular power, maximal linear sprint speed, change of direction skill, and intermittent aerobic endurance. Players completed a vertical jump assessment (Vertec, Swift Performance Equipment, Australia) to determine their lower body muscular power. Standing height was recorded as the highest rotating vane they could displace without lifting their heels off the ground. Players' jump height was determined through two countermovement jumps with no restrictions. The greatest difference between standing and jump height was recorded as their final score. Maximal linear sprint speed was assessed over a 30 m distance. Telemetric electronic timing cells (SmartSpeed Pro, Fusion Sport, Australia) were set at 5 and 30 m to record split times. Sprints were completed from a standing start, 0.5 m behind the first timing gate with the best 5 and 30 m splits from two trials recorded. Change of direction skill was quantified using a modified t-test protocol (Deprez et al., 2015b). Two assessors recorded split times using hand-held stopwatches. Recording commenced when the player lifted their heel off the ground and ceased when the first part of the player's body passed through the virtual gate. The average time between assessors was recorded for analyses. The ICC for change of direction skill was 0.96 with a mean difference of -0.01 s between measures. Players' intermittent aerobic endurance capacity was determined using the established Yo-Yo Intermittent Recovery Test – Level 1 protocol and expressed as the total distance covered (Krustrup et al., 2003).

Decision-making

A customised video-based decision-making assessment (study three) was performed on an iPad mini 2 (Model A1432, Apple Inc., United States of America). Players were shown 30 simulated attacking situations (2 vs. 1 = 4, 3 vs. 1 = 9, 3 vs. 2 = 6, 4 vs. 3 = 5, and 5 vs. 3 = 6) from a third person perspective. Five familiarisation trials were provided prior to the commencement of the assessment. The assessment paused at the critical decision moment, which coincided with the player wearing the yellow bib (i.e. the key decision-maker) receiving the ball. Players selected an interactive button corresponding with the response (i.e. dribble, pass, or shoot) that would directly lead to a goal scoring opportunity. Response accuracy was determined using previously established guidelines (Vaeyens et al., 2007a; Vaeyens et al., 2007b). Response time was recorded as the time between the occlusion of a video and the registration of a response action. This video-based decision-making assessment shows some construct validity, but lacks discriminant validity, in a sample of Australian youth soccer players. It was deemed necessary to include this assessment within the current study as previous research in both individual (Novak et al., 2018a, 2018b) and team sports (O'Connor et al., 2016; Woods et al., 2016b) showed video-based decision-making assessment to contribute to multifactorial models of performance. In addition, it was also important to replicate previous research in older youth soccer players which detailed significant differences between playing levels (Keller et al., 2018b), despite a lack of information surrounding the validity of the assessment.

Psychological traits

Players' completed the Task and Ego Orientation Questionnaire in Sport (Appendix 9) to determine their goal orientation towards sporting success (Duda, 1989). This questionnaire asks players to refer to the statement "I feel most successful in sport when …" and allocate a score between 1 and 5 (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree) based on their level of agreement with the question. Scores from questions 1, 3, 4, 6, 9, and 11 were averaged to quantify ego orientation, whereas scores from questions 2, 5, 7, 10, 12, and 13 were averaged to quantify task orientation. Higher scores indicate that the player is more inclined towards that particular goal orientation.

Statistical analysis

A Kolmogorov-Smirnov test and visual inspection of the Q-Q plots and histograms were used to assess the assumptions of normality. Descriptive statistics were calculated for all variables and presented as mean ± SD. Linear discriminant analyses were conducted to determine the classification accuracy of all multifactorial variables (anthropometry × motor competence × physical fitness × decision-making skill × psychological traits) for each age group (early adolescence and mid-adolescence). The grouping variable for these analyses was the pre-determined academy status: tier one and tier two. Subsequent stepwise discriminant analyses were completed to determine the strongest correlates of academy status for each age group. The same grouping variable was used. Multivariate statistics were interpreted at a criterion alpha level of significance of $p < 0.05$. All statistical analyses were conducted using SPSS software (Version 25.0, IBM Corporation, United States of America).

Results

Table 7.1 details the descriptive statistics for early and mid-adolescent youth soccer players.

Early adolescence

The linear discriminant function correctly classified 97.4% of players into their respective playing levels (tier one = 96.3% and tier two = 100.0%). One false-positive was evident in the data. A tier one player was classified as a member of the tier two academy. One standardised canonical discriminant function was generated containing all multifactorial variables (Eigenvalue = 3.59, Canonical Correlation = 0.88). The canonical correlation coefficient was deemed to be significantly different from zero ($\lambda = 0.22$, $\chi^2 = 44.96$, $p < 0.01$).

A stepwise discriminant analysis identified four predictor variables (Table 7.2). The discriminant function yielded a classification accuracy of 76.9% (tier one = 93.3% and tier two = 66.7%), with a total of 18 false-positives evident. Sixteen tier two players were classified as members of the tier one academy, whereas two tier one players were classified as members of the tier two academy. One standardised canonical discriminant function was generated (Eigenvalue = 1.82, Canonical Correlation = 0.80) and was considered significantly different from zero ($\lambda = 0.36$, $\chi^2 = 40.41$, $p < 0.01$). The following equation was used to classify youth soccer players into their respective academies:

- Tier one academy discriminant score = -594.915 + (2.763 × body mass) + (0.807 × balancing backwards score) + (422.904 × 5 m sprint time) + (66.761 × t-test time)

- Tier two academy discriminant score = -630.2721 + (3.006 × body mass) + (0.684 × balancing backwards score) + (493.960 × 5 m sprint time) + (60.756 × t-test time)

Mid-adolescence

The linear discriminant function correctly classified 100.0% of players into their respective playing levels. One standardised canonical discriminant function was generated containing all multifactorial variables (Eigenvalue = 9.19, Canonical Correlation = 0.95). The canonical correlation coefficient was deemed to be significantly different from zero ($\lambda = 0.10$, $\chi^2 = 41.78$, $p < 0.01$).

A stepwise discriminant analysis identified four predictor variables (Table 7.3). The discriminant function yielded a classification accuracy of 85.2% (tier one = 85.2% and tier two = 85.2%), with a total of 8 false-positives evident. Four players from each academy were classified as members of the opposite academy. One standardised canonical discriminant function was generated (Eigenvalue = 3.000, Canonical Correlation = 0.866) and was considered significantly different from zero ($\lambda = 0.25$, $\chi^2 = 37.43$, $p < 0.01$). The following equation was used to classify youth soccer players into their respective academies:

- Tier one academy discriminant score = -259.847 – (0.343 × balancing backwards score) + (538.858 × 5 m sprint time) – (0.191 × 3 vs. 1 response accuracy) + (29.999 × 3 vs. 1 response time)
- Tier two academy discriminant score = -325.641 – (0.624 × balancing backwards score) + (627.469 × 5 m sprint time) – (0.359 × 3 vs. 1 response accuracy) + (34.485 × 3 vs. 1 response time)

Table 7.1. The descriptive statistics for early and mid-adolescent youth soccer players' performance characteristics (mean ± SD).

	Early adolescence		**Mid-adolescence**	
	Tier one (n = 27)	**Tier two (n = 16)**	**Tier one (n = 18)**	**Tier two (n = 13)**
Anthropometry				
Stature (cm)	156.8 ± 8.9	157.6 ± 10.3	172.2 ± 6.5	170.3 ± 8.1
Body mass (kg)	44.0 ± 7.4	47.7 ± 12.6	59.7 ± 7.9	58.3 ± 10.6
Age at peak height velocity (y)	13.8 ± 0.6	13.9 ± 0.9	13.7 ± 0.5	13.9 ± 0.7
Motor competence				
Balancing backwards (points)	56.1 ± 11.4	48.9 ± 9.1	57.3 ± 8.1	49.4 ± 10.4
Moving sideways (points)	58.9 ± 8.0	54.8 ± 5.6	64.5 ± 8.4	59.5 ± 10.8
Jumping sideways (points)	96.5 ± 13.6	88.4 ± 9.0	102.6 ± 13.5	91.6 ± 7.7
Physical fitness				
Vertical jump (cm)	41.0 ± 5.2	43.6 ± 8.4	52.4 ± 6.6	50.4 ± 5.7
5 m sprint (s)	1.10 ± 0.05	1.17 ± 0.08	0.98 ± 0.05	1.07 ± 0.06
30 m sprint (s)	4.84 ± 0.16	4.97 ± 0.36	4.28 ± 0.19	4.55 ± 0.26
T-test (s)	8.35 ± 0.31	8.27 ± 0.36	7.82 ± 0.23	7.90 ± 0.27
Yo-Yo (m)	960 ± 411	937 ± 238	1619 ± 406	1563 ± 354
Decision-making				
2 vs. 1 response accuracy (%)	99.1 ± 4.8	98.4 ± 6.3	100.0 ± 0.0	100.0 ± 0.0
3 vs. 1 response accuracy (%)	85.2 ± 10.8	81.3 ± 13.5	88.5 ± 9.4	89.5 ± 11.3
3 vs. 2 response accuracy (%)	82.1 ± 15.1	70.8 ± 25.4	84.3 ± 16.4	88.0 ± 13.8
4 vs. 3 response accuracy (%)	85.9 ± 17.4	67.1 ± 26.5	91.5 ± 10.7	77.4 ± 21.2
5 vs. 3 response accuracy (%)	83.3 ± 11.2	73.3 ± 19.4	78.1 ± 16.1	84.2 ± 11.1
2 vs. 1 response time (s)	0.97 ± 0.41	0.91 ± 0.37	0.88 ± 0.32	0.70 ± 0.22
3 vs. 1 response time (s)	1.16 ± 0.60	0.95 ± 0.38	0.96 ± 0.45	0.96 ± 0.52
3 vs. 2 response time (s)	1.43 ± 1.09	0.97 ± 0.37	1.02 ± 0.35	1.05 ± 0.81
4 vs. 3 response time (s)	1.68 ± 1.17	1.28 ± 0.49	1.35 ± 0.60	1.06 ± 0.28
5 vs. 3 response time (s)	1.82 ± 1.10	1.18 ± 0.60	1.25 ± 0.62	0.83 ± 0.28
Psychological traits				
Ego orientation	2.9 ± 0.9	2.6 ± 0.9	3.0 ± 0.8	2.7 ± 0.8
Task orientation	4.4 ± 0.4	4.1 ± 0.6	4.2 ± 0.4	4.1 ± 0.5

Table 7.2. The variables entered/removed in the early adolescence group's stepwise discriminant analysis.

		Wilks's Lambda							
						Exact F			
Steps	Entered	Statistic	df1	df2	df3	Statistic	df1	df2	*p*
1	5 m sprint time	0.69	1	1	41	18.65	1	41	< 0.01
2	Body mass	0.49	2	1	41	21.07	2	40	< 0.01
3	T-test time	0.41	3	1	41	18.66	3	39	< 0.01
4	Balancing backwards score	0.36	4	1	41	17.28	4	38	< 0.01

Table 7.3. The variables entered/removed in the mid-adolescence group's stepwise discriminant analysis.

		Wilks's Lambda							
						Exact F			
Steps	Entered	Statistic	df1	df2	df3	Statistic	df1	df2	*p*
1	5 m sprint time	0.47	1	1	29	33.15	1	29	< 0.01
2	Balancing backwards score	0.36	2	1	29	24.65	2	28	< 0.01
3	3 vs. 1 response time	0.29	3	1	29	21.75	3	27	< 0.01
4	3 vs. 1 response accuracy	0.25	4	1	29	19.50	4	26	< 0.01

Discussion

The current study aimed to determine the performance characteristics that discriminate Australian youth soccer players based on their academy status. Early adolescent players were grouped according to their body mass, dynamic balancing ability, linear sprint speed over 5 m, and change of direction skill. These performance characteristics, except for body mass, were higher in the tier one academy players when compared to those in the tier two academy. In the mid-adolescence group, dynamic balancing ability, linear sprint speed over 5 m, 3 vs. 1 response accuracy, and 3 vs. 1 response time were significant predictors of academy status. Tier one academy players scored better for dynamic balancing ability and were faster over 5 m, when compared with tier two academy players. However, tier two academy players were marginally better at making decisions in the simulated 3 vs. 1 situations than tier one academy players.

The present study's results indicate that better dynamic balancing ability is a significant predictor of academy status in both younger and older youth soccer players. This finding is in support of some talent identification research demonstrating both overall and individual aspects of motor competence to discriminate high and low-level athletes in gymnastics (Vandorpe et al., 2011) and soccer (Deprez et al., 2015b). However, the signficance of dynamic balancing ability in the current study is different to the components of motor competence (i.e. moving sideways and jumping sideways) that Deprez et al. (2015b) reported to discriminate high-level Belgian academy players from those who dropped out of a development program. Furthermore, it is important to highlight that motor competence is not a significant predictor of selection status in other team sports such as Australian Football (Tribolet, Bennett, Watsford, & Fransen, 2018). A possible explanation for the limited discriminant ability of motor competence in Australian sports is that Belgian children are reported to outperform Australian children on assessments of moving and jumping sideways, with no differences observed in dynamic balancing ability (Bardid, Rudd, Lenoir, Polman, & Barnett, 2015). Together, these findings demonstrate that overall motor competence likely lacks the sensitivity to discriminant playing level differences in Australia. However, certain components such as dynamic balancing ability may prove useful.

It was also identified that both anthropometry and physical fitness characteristics were significant predictors of academy status. However, tier one academy players presented a lower body mass as opposed to the expected higher body mass. This finding is in contrast to numerous other studies who reported high-level players to show greater stature and body mass when compared with those players competing at lower levels (Coelho-e-Silva et al., 2010; Deprez et al., 2015b; Le Gall et al., 2010). The present findings support previous studies that have shown superior physical fitness in high-level players when compared with lower level players (Coelho-e-Silva et al., 2010; Deprez et al., 2015b; Gil et al., 2014b; Gonaus & Müller, 2012; Le Gall et al., 2010; Vaeyens et al., 2006). The significant contribution of physical fitness variables to academy status might result from more exposure to systematic training in the tier one academy when compared with the tier two academy, as age at peak height velocity – a commonly used measure of biological maturity – was similar between groups.

A current finding that only partially agrees with previous research is the small contribution of decision-making performance to academy status. Previously, decision-making performance was reported to discriminate playing levels in Australian youth soccer players (Keller et al., 2018b; O'Connor et al., 2016). Similarly, greater decision-making performances are apparent in high-level Belgian youth soccer players when compared with those competing at lower levels (Vaeyens et al., 2007a). Such findings are also evident in other team sports such as Australian Football, with talent-identified players showing greater decision-making performances than non-identified players in a video-based assessment (Woods, Raynor, Bruce, & McDonald, 2016a). Despite several studies reporting playing level differences in decision-making performance (Keller et al., 2018b; O'Connor et al., 2016), there is a limited understanding of the construct validity of many of the employed methodological designs. In addition, the task representativeness of computerised video-based assessments are questionable, as altering the execution of a soccer-specific skill (e.g. clicking an iPad screen, verbalising a response, or circling the intended action using pen and paper) likely conceals true perceptual-cognitive and decision-making skill differences (Travassos et al., 2013). Future research should aim to develop task representative designs to strengthen multifactorial models of players' performance characteristics.

An unexpected finding was that a higher task orientation did not contribute to the playing level differences between the tier one and two academy players. These findings are different to previous research that reported higher task orientation in successful youth soccer players (Reilly et al., 2000; Zuber et al., 2015). However, the current study's findings support Huijgen et al. (2014) who showed no differences in task or ego orientation between selected and de-selected Dutch youth soccer players. From the view of the current study, it is noted that a higher task orientation was more prevalent than a higher ego orientation in each academy and age group. While playing level differences in goal orientation differ across studies, it remains difficult to ascertain whether these variables mediate or directly influence talent development and whether the influence changes over time (Gledhill et al., 2017).

Collectively, the present study's findings provide further insight into Australian youth soccer players' performance characteristics. Despite, FFA focusing on developing technically and tactically gifted players, the tier one academy that was assessed in this study seemed to favour players who were physically advanced. In fact, there was an indication that players who develop outside of this tier one academy possessed superior decision-making skills. Notably, the observed higher linear sprint speed, and change of direction skill in tier one academy players does not necessarily reflect the talent status of these individuals or implicate that they have greater chance of achieving future playing success. It is positioned that football nations like Australia maximise the size and the depth of their talent pool (study one). Unequivocally, if players are selected into tier one academies based on superior physical variables, there is an increased likelihood that players who develop outside of these academies will have a lower chance of later identification or selection (i.e. side-entry). This is concerning, as an early systematic bias towards physically superior players will create a rather homogenous talent pool later in development without identifying players with the most future playing potential. Therefore, it is essential that other initiatives are implemented to provide access to high-quality coaching support and appropriate development environments. An example currently underway within Australia is the 'Talent Support Programs' which provide players outside of tier one academies with additional training support and competitive matches to further supplement their development.

Limitations

When interpreting the current study's findings, there are some limitations to consider. The present study was only a cross-sectional representation of a cohort of youth soccer players from two playing regions within Australia. As a result, players were sub-divided into two *a-priori* playing levels based on the selection processes that the academy program used to recruit players. Consequently, it is only possible to infer these performance characteristics are indicative of their current talent identification practice. Future research should extend on longitudinal and retrospective investigations (Deprez et al., 2015b; Emmonds et al., 2016; Höner et al., 2017) and determine which performance characteristics distinguish between players in Australia who sign a professional contract and develop career success, and those who do not. In addition, while many performance characteristics were measured, no consideration was given to players' soccer-specific skills. With more task representative assessments of soccer-specific skill available (study two), future research should aim to include such data as part of a multifactorial design. Finally, the relatively small sample size in the current study might not accurately represent the trends within the entire population.

Conclusion

Overall, certain components of players' anthropometry, motor competence, physical fitness, and decision-making skills differed significantly between academies in two age groups of youth soccer in Australia. Specific predictors of early adolescent tier one Australian academy status include: body mass, dynamic balancing ability, linear sprint speed over 5 m, and change of direction skill. In comparison, the most significant predictors of mid-adolescent tier one Australian academy status were dynamic balancing ability, linear sprint speed over 5 m, 3 vs. 1 response accuracy, and 3 vs. 1 response time. It is important for Australia to minimise any potential playing level differences based on physical superiorities. This will provide younger players who develop outside tier one academies – who may possess superior decision-making skills – with an opportunity to contest selection into older talent squads. Subsequently, this approach will assist with increasing the size and depth of the available talent pool. However, future research is needed to extend on the current study's findings to determine if the potential selection biases extend to other academy programs.

Practical implications

There are several practical implications which are derived from this study:

- Coaches and sporting professionals need to consider the physical biases evident in tier one academy programs
- The inclusion of a dynamic balancing ability provides useful information for talent identification
- Governing bodies and sporting organisations should maximise the developmental opportunities for players competing outside of the tier one academies
- A reduced focus on talent identification is needed to maximise the size and depth of the talent pool

Chapter eight:

General discussion

The landscape of talent identification in established football nations

Following a comprehensive analysis of the current talent identification and development research, it was clear that an emphasis is placed on understanding the contribution of players' performance characteristics to quantifying future playing potential (study one). Overall, the talent pool in established football nations usually favours relatively older and/or more mature players as opposed to those who are relatively younger and/or less mature (Figueiredo et al., 2009b; Helsen et al., 2012; Johnson et al., 2017; Roman & Fuchslocher, 2013). The bias towards these players is usually due to the associated superior performance characteristics at younger ages (e.g. anthropometry and physical fitness), which coaches and sporting professionals misconstrue as a greater potential for future success (Furley & Memmert, 2016; Peña-González, Fernández-Fernández, Moya-Ramón, & Cervelló, 2018). It was also evident that there is a lack of practical, validated, soccer-specific and perceptual-cognitive skills assessments that replicate the demands of competitive match-play and can measure true differences in soccer expertise. Finally, there was insufficient evidence in established football nations that supported the effectiveness of talent identification to assist with the development of soccer expertise. Therefore, it is unknown whether emerging football nations, who have different talent identification and development requirements, should adopt the same approach as established football nations or develop their own model.

Australia as an emerging football nation

Australia was selected as a practical example of an emerging football nation for several reasons. First, the national team has largely struggled to find success in international tournaments, especially when competing against highly ranked nations. Second, the domestic competition (i.e. Hyundai A-League) is noticeably less established than other nations (e.g. English Premier League, La Liga, and Ligue 1). For example, the average salary in the A-League is approximately $61,000 AUD when compared with $4.6 million AUD in the English Premier League (Professional Footballers Australia, 2018; Sporting Intelligence, 2017). Third, the depth of the talent pool is relatively small, despite the popularity of soccer amongst youth athletes (Australian Sports Commision, 2016). In addition, high-level development programs are exclusive and only a limited number of opportunities are available to a small group of talented players at a substantial cost. Finally, there is limited research that details the current landscape of talent identification and development in Australia. Noticeably, out of the 61 studies included in chapter two, only five were completed in Australia, with three coming from the same sample of players. Due to these reasons, it was deemed that Australia could not simply apply the widespread approaches employed in established football nations as it would significantly impact on the idea of what constitutes a talented player and how they should be identified. Furthermore, any biases in the talent pool would likely have considerably greater effects because of the exclusive nature of talent development programs.

Major findings

A series of studies were completed to create strategies that could address some of the limitations of current research in established football nations. In addition, these studies aimed to provide a greater understanding of the talent identification and development landscape in Australia. Study two investigated the efficacy of small-sided games as a soccer-specific skills assessment. Combined and individual measures of skill proficiency were successful at discriminating high from low-level players. Furthermore, with bout duration having a limited effect on skill proficiency, the external and ecological validity of small-sided games as a talent identification tool was maximised. Study three employed a practical video-based decision-making assessment and determined its construct and discriminant validity. Although the task demonstrated two theoretical constructs and was soccer-specific in nature, it lacked the sensitivity to measure true differences in decision-making expertise. Study four provided information on the confounding influences of players' previous sporting participation history on commonly used generic and sport-specific talent identification assessments. Notably, differences in the start age in competitive soccer, the total volume of soccer-specific practice, the total volume of peer-led play, and participation in other sports resulted in different performance profiles. Finally, study five described the multifactorial nature of Australian youth soccer players' performance characteristics and identified playing level differences. There is a chance that Australian players are selected into high-level academies based on superiorities in their physical fitness. There was also an indication that players participating at lower levels possessed superior decision-making skills.

Small-sided games in talent identification

Study two supported the use of small-sided games as a soccer-specific skills assessment in talent identification. High-level players were more proficient overall in small-sided games and made less passing and controlling the ball errors than low-level players. In addition, bout duration did not affect players' skill proficiency during small-sided games. Based on the findings of study two, the benefits of small-sided games in talent identification are twofold. First, small-sided games allowed players to compete in a task-representative performance environment that couples the sequential execution of multiple soccer-specific skills with perceptual-cognitive processes. With players problem-solving more frequently than what they do in match-play (Joo et al., 2016), it is proposed that skill proficiency data is a preliminary measure of future playing potential as it provides information on a player's adaptability to different match-based contexts. However, it is acknowledged that the skills completed in small-sided games are only one component of future playing potential. Second, small-sided games are externally and ecologically valid for talent identification because coaches and sporting professionals can complete multiple assessments with minimal time commitments. Furthermore, coaches and sporting professionals can couple their subjective opinions of player's soccer-specific skills with objective data. Doing so will help to minimise any cognitive biases, which could confound the coaches and sporting professionals assessment of soccer specific skills (Furley & Memmert, 2016).

Video-based decision-making assessments in talent identification

Study three examined the applicability of a practical video-based decision-making assessment in talent identification. Overall, the assessment displayed some construct validity with developmental stage, years playing soccer, and situation influencing decision-making performance. While the assessment was able to discriminate youth academy soccer players from the control group using response accuracy, it lacked the sensitivity to determine inter-academy differences in decision-making performance. A similar trend was observed in study five, with only a small contribution of video-based decision-making assessment performance to playing level classifications. Together, the findings from study three and five have important implications for the use of video-based decision-making assessments in talent identification. It is advised that coaches and sporting professionals apply caution when using video-based decision-making assessments until further research has validated new methodological designs and discovered ways to measure soccer-specific perceptual-cognitive skills. Currently, most video-based decision-making assessments include a non-specific response action (i.e. verbal responses, written responses, or clicking an iPad screen) and will likely provide misleading information if used as a measure of future playing potential (Travassos et al., 2013).

Sporting participation history as a confounder in talent identification

The findings from study four recognise the confounding influence of sporting participation history on generic and specific measures used in talent identification. An earlier start age in competitive soccer, a higher total volume of soccer-specific practice, and a higher total volume of peer-led play was associated with superior motor competence. Furthermore, less participation in other sports and a higher total volume of peer-led play was related to superior physical fitness. While study four provided a valuable insight into the potential effects of sporting participation history on motor competence and physical fitness in youth soccer players, the practical implementation of sporting participation history in talent identification is not straightforward. Unlike other confounders such as biological maturation and relative age effects, sporting participation history requires multiple output measures. Accordingly, there is a complex interaction between these measures, which makes the inclusion of sporting participation history in talent identification practice challenging. In addition, there are limited validated methodologies to describe the impact of the quality of these measures. While sporting participation history is a complicated confounding factor in talent identification, it is important that coaches and sporting professionals start concurrently tracking players' sporting participation history. This will allow for the collection of more valid data and assist with further determining the impact of sporting participation history on talent identification.

Playing level biases in talent identification

Study five provided a multifactorial analysis of early and mid-adolescent Australian youth soccer players from two playing levels. The strongest indicators of a higher playing level in early adolescence was: body mass, dynamic balancing ability, linear sprint speed, and change of direction skill. As the sample became more homogenous in mid-adolescence, the strongest predictors of a higher playing level were: dynamic balancing ability, linear sprint speed, and 3 vs. 1 response accuracy and time. Generally, players from a higher level presented with superior performances in each of these characteristics, except for decision-making where lower level players performed slightly better. Together, the findings from study five highlight a potential problem in the current Australian youth academy system, if similar trends are observed in other playing regions. It appears that there is a tendency to favour physically advanced players, despite FFA stressing the importance of developing technically and tactically gifted players. Providing these physical biases are actually evident during the initial selection of players into the academy program, coaches and sporting professionals can implement small-sided games to collect valid and objective data on players' soccer-specific skills. As an emerging football nation, it is important for Australia to minimise playing level differences between academies that are of a physical nature. With most high-level academies competing under the National Premier League structure, there are restrictions on how many players they can register in each age group. Consequently, a substantial portion of Australia's talent pool is developing outside of high-level academies. Therefore, it is suggested that Australian academies adopt a collaborative, multi-stage approach to talent identification.

A multi-stage model for talent identification in Australia

Figure 8.1 illustrates an example of a multi-stage model that FFA can adopt to maximise the size and depth of the available talent pool. The initial stage of talent identification coincides with the first-year tier one, two, and three academies can recruit youth soccer players into their development programs. As study one suggested that emerging football nations should relax their selection criteria, the goal of this talent identification stage is to identify 'above average' and 'below average' performers across multiple domains. Some guiding principles that coaches and sporting professionals can follow in this stage include: (1) pairing commonly used base measures (e.g. anthropometry, physical fitness, coaches' opinions, and scouting reports) with essential (e.g. motor competence, soccer-specific skills, perceptual-cognitive skills, and psychological traits) and confounding (e.g. biological maturation, relative age, and sporting participation history) measures, (2) retaining late maturing and/or relatively younger players with 'below average' base measures if they display 'above average' performances in one or more of the essential measures, and (3) prioritising players with 'above average' performances in essential measures over those with 'above average' performances in the base measures. Following the initial stage of talent identification, it is key that the original talent pool is re-assessed in the under-14, under-15 and under-16 age groups. This allows for the development of performance profiles, which track the temporal changes in players' performance characteristics over time. The final stage of talent identification is where coaches and sporting professionals identify the players with the greatest likelihood of becoming a successful senior player. While this is a rather difficult stage, coaches and sporting professionals can strengthen their subjective opinions with four years of data on players' performance characteristics and their overall development.

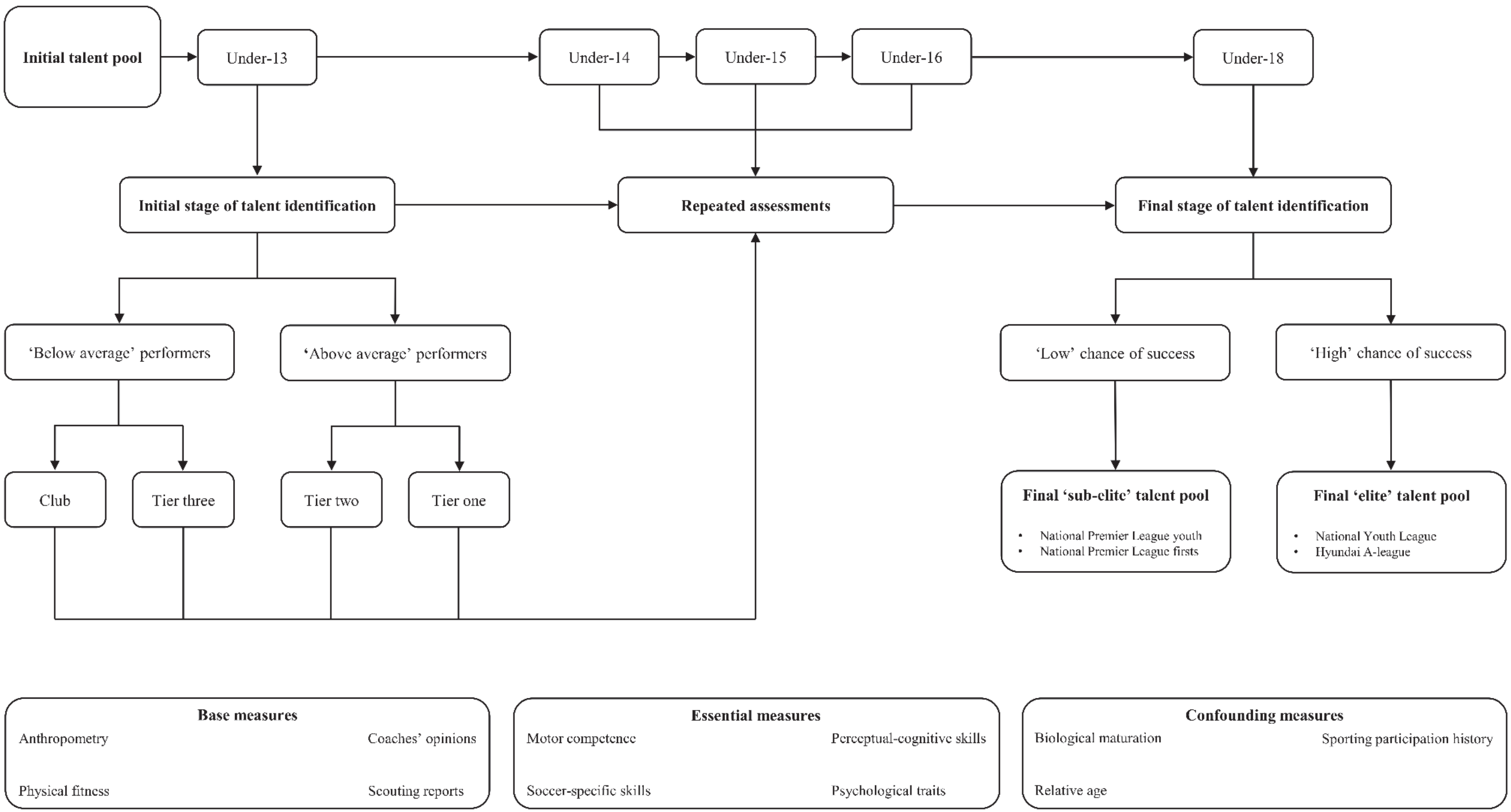

Figure 8.1. A proposed multi-stage talent identification model to maximise the size and depth of the available talent pool in Australia.

Limitations

While the specific limitations of each study are presented in their respective chapters, there are some limitations that apply to the overall findings of the thesis. First, players were recruited from a small sample of youth academies within the Northern NSW and Football NSW playing regions. Accordingly, the findings might not be representative of the entire population of Australian youth soccer players. Furthermore, the selection process of each academy within these playing regions likely influenced the observed findings. Second, one of the major limitations of talent identification research is the lack of clear response variables that are indicative of future playing success. As study four and five completed cross-sectional analyses and did not track players' longitudinally, their practical implications warrant further verification. Third, due to the logistical constraints of testing at multiple locations, numerous trained assessors were involved during the data collection process. Without a measure of inter-rater reliability, there is a possibility that the inherent variability in the assessment of youth soccer players' performance characteristics impacted on the findings of the current thesis. Finally, as with most of the talent identification research, it was assumed that all players provided a maximal effort throughout the data collection process. Therefore, players' motivational levels may have confounded the observed findings.

Practical implications

From the findings in the present thesis, several practical implications are derived for talent identification and development practice. While these findings are discussed from the perspective of an emerging football nation, the implications are still applicable to established football nations.

- Emerging football nations should reduce the active deselection of players and maximise the size and depth of the talent pool.
- A worthwhile strategy to reduce active deselection is the development of task representative designs, which are needed to allow true expertise differences between talented youth soccer players to emerge.
- Small-sided games provide a representative measure of soccer-specific skills and account for some of the limitations of traditional assessments
- When including decision-making assessments in multifactorial talent identification models, it is imperative that the perception-action coupling closely resembles the processes used in competitive match-play.
- Motor competence is a useful generic measure in multifactorial talent identification models. However, more comprehensive assessments batteries might be needed to improve discriminative power. Identifying players with low motor competence and providing tailored interventions might also prove valuable in decreasing dropout from high-level development programs (Deprez et al., 2015b).
- One of the most important strategies to minimise selection biases within talent identification and development programs is accounting for the influences of confounding factors. Based on the available evidence and the findings of this thesis, these include: biological maturation, relative age effects, and sporting participation history.

Chapter nine:

Summary and recommendations

Thesis summary

The current thesis aimed to bridge the gap between established and emerging football nation's talent identification and development research. Study one provided an insight into how established football nations determined future playing potential and recognised some of the limitations of current practice. It appeared that established football nations emphasised physical prowess, with numerous selection biases reported in favour of high-level youth players. These biases were evident despite studies reporting an association between superior physical performance data and confounding factors such as biological maturation and relative age effects. The inclusion of other performance characteristics (e.g. soccer-specific skills, perceptual-cognitive skills, and psychological traits) as part of multifactorial designs were increasingly prevalent. However, the task representativeness of the employed methodologies was often questioned. As such, it was deemed necessary to conduct further studies to address the overreliance on physical performance data.

The first step was to develop two methodological designs that assessed soccer-specific and perceptual-cognitive skills (study two and three, respectively). While small-sided games provided a task representative measure of soccer-specific skills, the video-based decision-making assessment lacked the utility for use in talent identification practice, as it was unsuccessful at discriminating playing levels. The second step was to examine the state of talent identification and development practice in an emerging football nation. To do so, generic and specific measures used in talent identification were assessed in Australian youth soccer players to determine the influence of confounding factors. Study four demonstrated that coaches and sporting professionals should consider sporting participation history as a confounding factor, alongside biological maturation, and relative age effects. An earlier start age in competitive soccer, a greater total volume of soccer-specific practice, and peer-led play, were associated with superior motor

competence. Whereas, less participation in other sports were linked with superior physical fitness. Study five showed that motor competence and physical fitness performance largely explained the variance between high and low-level players. This is concerning as there is a possibility that selection biases, rather than a greater playing potential, were the underlying reasons for the playing level differences. However, it is also possible that the playing level differences were a result of increased exposure to systematic training in the tier one academy programs. It is recommended that emerging football nations maximise the size and depth of their available talent pool through reducing active deselection, accounting for confounders, and implementing task representative soccer-specific and perceptual-cognitive skills assessments.

Future research directions

While the overall findings from this thesis are promising, it is essential that further comprehensive studies are conducted in emerging football nations. Some avenues of future research include:

- The use of small-sided games as a combined talent identification and development measure

Study two imposed specific small-sided games constraints (i.e. number of participating players, field dimensions, and rules) to establish the validity of the assessment for talent identification. The key response variable in study two was a player's skill proficiency, both in their individual skills (i.e. dribbling, passing, ball control, and shooting) and based on their overall involvement. While this metric proved valuable for talent identification purposes, it is proposed that a player's skill adaptability – the reproducibility of skill proficiency under different environmental constraints – is of significance for talent development. To test this hypothesis, researchers can manipulate the constraints of the small-sided games, to provide a holistic measure of skill adaptability. For example, small, medium, and large field dimensions create environments where players must perform under high, moderate, and low pressure, respectively. In this instance, the players with the greatest skill adaptability are those who can maintain their proficiency across the conditions. Within future research, it is also important to collect additional data on small-sided games reliability and construct validity. This will allow coaches, sporting professionals, and researchers to determine the reproducibility of small-sided games skill performance and determine whether it is transferable to match-play.

- The development of task-representative decision-making assessments

A significant finding from this thesis was that video-based decision-making assessments lack the sensitivity to measure true differences in expertise, especially when non-specific response actions are used. While mobile technology was able to increase the external validity of the assessment, having players not execute the soccer-specific skill in response to a video situation reduced the task representativeness of the design (Travassos et al., 2013). It is imperative that future research bridges the gap in talent identification and develops task-representative, decision-making assessments that possess high external validity. With the continuing advancements in virtual reality, it might be possible to immerse players in realistic match-based environments and measure their response to varying situations.

- Collective measures of quantity and quality in sporting participation history

Study four provided preliminary support for the confounding influences of a players' previous sporting participation on generic and specific measures used in talent identification. However, before coaches and sporting professionals can include measures of previous sporting participation in talent identification, it is important to understand the interaction between the quantity of developmental activities (e.g. soccer-specific practice, peer-led play, and number of other sports) and the quality of the players' involvement. Currently, it is rather difficult to measure quality, without some degree of subjectivity. Therefore, two stages of future research are required: (1) establish an objective measure of quality, and (2) measure the interaction effects between quantity and quality of sporting participation history on generic and specific measures used in talent identification.

- The performance characteristics related to objectively defined future playing success

Although playing level differences were identified in study five, the validity of physical fitness data for talent identification remains disputed. The cross-sectional nature of study five, limits the causal interpretation of its findings and makes it difficult to pinpoint the direct influence of the reported selection biases on the size of the talent pool. Future research in emerging football nations should focus on multifactorial, longitudinal study designs that track players over several years of development. Within these studies, a focus is needed on performance characteristics that are not extensively investigated. These include: motor competence, soccer-specific skills, perceptual-cognitive skills, and psychological traits. It is important that the response variables are clearly defined, with an emphasis placed on players who sign a professional contract and those who maintain a professional status for numerous years.

- The relationship between motor competence and talent development

Study five showed support for the inclusion of a motor competence assessment as part of a multifactorial design for talent identification. Motor competence serves as the foundation for future skill development (Vandorpe et al., 2011) and helps to reduce dropout from academy programs (Deprez et al., 2015b). Although the relationship between motor competence and physical fitness is established in the general population

(Stodden, Langendorfer, & Roberton, 2009; Stodden et al., 2008), it is still uncertain whether superior motor competence is related to more favourable performance outcomes in youth soccer. This is an area that future research should address.

Chapter 10:

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Chapter 11:

Appendices

Appendix 1: Human Research Ethics Approval

Dear Applicant

[Transfer of ethics application: University of Newcastle HREC (RIMS): H20150081]

The UTS Human Research Ethics Expedited Review Committee reviewed your application titled, "A Multidimensional approach to talent identification and talent development in youth sports", and agreed that the application meets the requirements of the NHMRC National Statement on Ethical Conduct In Human Research (2007). I am pleased to inform you that your external ethics approval has been transferred. We will be writing to the (COMMITTEE NAME) HREC to inform them that UTS HREC has accepted responsibility for the ethical oversight of this protocol.

Your approval number is UTS HREC REF NO. ETH16-0634 Approval will be for a period of five (5) years from the date of this correspondence subject to the provision of annual reports.

Please note that the ethical conduct of research is an on-going process. The National Statement on Ethical Conduct in Research Involving Humans requires us to obtain a report about the progress of the research, and in particular about any changes to the research which may have ethical implications. This report form must be completed at least annually, and at the end of the project (if it takes more than a year). The Ethics Secretariat will contact you when it is time to complete your first report.

I also refer you to the AVCC guidelines relating to the storage of data, which require that data be kept for a minimum of 5 years after publication of research. However, in NSW, longer retention requirements are required for research on human subjects with potential long-term effects, research with long-term environmental effects, or research considered of national or international significance, importance, or controversy. If the data from this research project falls into one of these categories, contact University Records for advice on long-term retention.

You should consider this your official letter of approval. If you require a hardcopy please contact Research.Ethics@uts.edu.au.

If you have any queries about your ethics approval, or require any amendments to your research in the future, please do not hesitate to contact Research.Ethics@uts.edu.au.

Yours sincerely,

Professor Marion Haas
Chairperson
UTS Human Research Ethics Committee
C/- Research & Innovation Office
University of Technology, Sydney
E: Research.Ethics@uts.edu.au

Appendix 2: Invitation Letter

(Date)

(Name)
(Position)
(Organisation)
(Postal Address)
(State, Postcode, Country)

Job Fransen
Lecturer
Sport and Exercise Science
Faculty of Health
Moore Park precinct
PO Box 123 Broadway
NSW 2007 Australia
T: +61 2 9514 5203
Job.Fransen@uts.edu.au
www.uts.edu.au

UTS CRICOS PROVIDER CODE 00099F

RE: A Multidimensional Approach to Talent Identification and Talent Development in Youth Sports

Dear (Name),

My name is Job Fransen and I am an academic at the University of Technology, Sydney. The purpose of this letter is to detail a research project that myself and My Kyle Bennett are completing.

The aim of this research project is to collect data on youth (enter sport) player's anthropometry, motor competence, physical fitness, decision-making ability, skill proficiency, previous sporting participation and psychological traits. In doing so, we will be able to develop a comprehensive database that can be used to assist coaches and sporting professionals in making informed decisions regarding the selection of talented players. Additionally, information gained from this research project can be used in the design of stimulating training environments for developmental purposes.

To complete this research, we are looking to recruit (enter sport) players aged 8 to 18 years. Upon the completion of the testing, all players will receive a customised report. If this research is of interest to you and your organisation I would kindly ask if you would like to pass on some information to your players. Participation in this research is completely voluntary and confidentiality of data will be strictly maintained.

Thank you for your time and consideration.

Kind regards,

Job Fransen

Note:
This study has been approved by the University of Technology Sydney Human Ethics Committee (UTS HREC). If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat ph: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote UTS HREC: ETH16-0634. Any matters raised will be treated confidentially, investigated and you will be informed of the outcome.

Appendix 3: Detailed Organisation Information Statement

Dr Job Fransen
Sport and Exercise Science, Faculty of Health
Moore Park precinct
PO BOX 123 Broadway, NSW 2007 Australia
T: +61 2 9514 5203 | E: Job.Fransen@uts.edu.au

Information Statement for the Research Project:
A Multidimensional Approach to Talent Identification and Talent Development in Youth Sports

Dr Job Fransen, Professor Aaron Coutts, and Mr Kyle Bennett

Document Version 9: Dated 01/11/2016

Who is doing the research?
The research is being conducting as part of Mr Kyle Bennett's Doctor of Philosophy at the University of Technology Sydney. The research is supervised by Dr Job Fransen.

Why is the research being done?
The purpose of the research is to assess anthropometry, motor competence, physical fitness, decision-making, skill proficiency, psychology traits and previous sporting participation to see which of these factors influence the identification and development of 'talent' in youth sports. Further, this research would like to examine if the above variables are affected by the month of year that you were born in. Currently, there seems to be an overrepresentation of players born right after the cut-off date for their competitive age group.

Who can participate in this research?
We are looking for boys and girls between 8 and 18 years old from all levels of individual and team sports. We encourage players of all levels and abilities to participate in this research, however it is important that if they have an electronic device inside their body (such as a pace maker) and they want to participate in this research, they notify one of the researchers through the signed informed consent form.

What would the player be asked to do?
If the player agrees to participate, they will be asked to perform a series low, moderate and high intensity tests where their anthropometry, motor competence, physical fitness, decision-making ability and skill proficiency will be assessed. The player will also be asked to complete a questionnaire on their sports participation history and your psychological goal orientation. Their permission will be sought for the organisation to provide specific information to the researchers about their: playing level (team); field position played during the year (if applicable); and attendance at training throughout the year.

What would the organisation be asked to do?
The organisation will be asked to assist with the recruitment of players by facilitating an information session hosted by the researchers, to inform players and their parents/guardians about the research. Participating organisations will also be asked to distribute the invitation to participate to eligible players and their parents/guardians. All the player assessments will be conducted on club grounds by trained researchers from the University of Technology, Sydney. We would ask that club officials be present during these sessions to provide player support. The data obtained by the researchers during these activities will then be combined into a large dataset that will be used to assess the factors that may influence talent identification and development.

What choice does the organisation and players have?
The involvement of the organisation in this research is voluntary. In addition, even where the organisation has agreed to be involved, participation in this research by individual players is entirely the player's (and their parent/guardian's) choice. Only those players who give their

informed consent will be included in the project. Whether they decide to participate, their decision must not disadvantage them in any way or affect their relationship with the organisation. It will also be up to individual players to decide whether a copy of their individual results can be provided to the organisation. If the player (and where relevant their parent/guardian) agrees to participate, he/she may withdraw from the project at any time without giving a reason and have the option of withdrawing any data that identifies him/her.

How much time will it take?
The assessments for this project will be conducted over three to four sessions (decision-making: 30 minutes; skill proficiency: 60 minutes; and multidimensional: 2.5 hours) at the club's grounds. These same sessions will be repeated annually and all players are encouraged to participate on each consecutive assessment. However, although encouraged, repeated participation over the duration of this study is not mandatory and any player can withdraw participation at any time.

What are the risks and benefits of participating?
The assessment sessions in this project involve short bouts of highly intensity physical activity and lasts for a considerable time (up to 2.5 hours). Therefore, assessments can cause mild discomfort, muscular soreness and/or fatigue.

The benefit of participating in this project is that it allows participants to identify 'growth areas' and 'talents' within their anthropometry, motor competence, physical fitness, decision-making, skill proficiency, psychological orientation and sports participation history. This may help participants optimize their development within their current sport. If the participant consents, a simple representation of these data will be made available to the club. While the organisation may choose to use this information to assist it in supporting players' growth areas and talents, the organisation is strongly discouraged from using this information to assess athletics career progression within the club.

How will the organisation's and player's privacy be protected?
The information collected by the researchers that might identify individuals within the organisation or the organisations themselves will be stored securely and only accessed by the researchers unless the players involved or their parents/guardians consent otherwise. These data will be retained for at least 5 years at the University of Technology, Sydney for research conducted by University staff and students and any personal identifiers or identifiers of the organisations within this data set will be replaced by anonymous identification numbers.

How will the information collected be used?
The information collected by the researchers will be used to write articles that will be published in scientific journals and will also contribute to the Mr Kyle Bennett's research thesis. However, in these outcomes, individual participants will not be identified. Upon completion of the assessments, data will be recorded on colour-coded or individual performance sheets that, with player consent, will be available for the sporting organisation at the latest 60 days after data collection. These sheets will give the organisation a short summary of the player's growth areas and talents. At the end of the project, a summary of the overall outcome of the research will be provided to the organisation, which can also be distributed to players and their parents/guardians.

What do you need to do to participate?
Please read this Information Statement and be sure you understand its contents before you consent to participate on behalf of your organisation. If there is anything you do not understand, or you have questions, contact the research team using the contact details heading of this letter. If your organisation would like to participate, please complete the attached informed consent form.

Further information
If you would like further information, please contact Dr Job Fransen at Job.Fransen@uts.edu.au or at +61 2 9514 5203; or Mr Kyle Bennett at Kyle.J.Bennett@student.uts.edu.au.

Thank you for considering this invitation.

Job Fransen
Lecturer
University of Technology Sydney

Kyle Bennett
PhD Student
University of Technology Sydney

Note:
This study has been approved by the University of Technology Sydney Human Ethics Committee (UTS HREC). If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat ph: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote UTS HREC: ETH16-0634. Any matters raised will be treated confidentially, investigated and you will be informed of the outcome

Appendix 4: Organisation Testing Summary

Insert Club

Logo Here

Insert Club Name – Research Proposal

Purpose of the Research

The purpose of this research is to provide a comprehensive understanding of the performance characteristics underlying talent in youth soccer within Australia. In particular, the research is focusing on: anthropometry, motor competence, physical fitness, skill proficiency, decision-making, psychological traits and previous sporting participation. The research will also aim to identify any possible confounding factors such as a player's biological maturation and month of birth relative to the selection year, which may influence the identification of talent. It is anticipated that the proposed research will aid in the development and refinement of current talent identification programs within youth soccer in Australia.

Research Overview

Data collection is split into three periods

Period 1 ¬– Small-Sided Games Protocol

Purpose:	To examine youth soccer player's skill proficiency during different small-sided game conditions
Commitment period:	2 sessions over a 2-week period (per age group)
Session duration:	60 minutes (per age group)
Number of participants:	8 outfield players + 2 substitutes (per age group – must have the same players each week)
Description:	Warm up (conducted by an accredited S&C coach): - Dynamic activations - Sprinting builds/change of direction preparation Small-sided game: - 4 vs. 4 - Completion of either 5 x 3 minutes or 3 x 5 minutes - Total duration of work: 15 minutes - Total duration of rest: 15 minutes Cool down (conducted by an accredited S&C coach) - Partner assisted stretching of major muscle groups

Period 2 – Decision Making Protocol

Purpose:	To quantify the decision-making ability of talented youth soccer players using a customised iOS application
Commitment period:	2 sessions over a four-week period (per age group) – Re-test trial four weeks after initial assessment
Session duration:	15-20 minutes (per age group)
Number of participants:	All players
Description:	Decision-making assessment - 5 min familiarisation (per 15 players) - 10 min assessment (per 15 players)

Period 3 – Multidimensional Analysis of Performance Characteristics

Purpose:	To determine the underlying characteristics of talented youth soccer players within Australia.
Commitment period:	2 sessions

Session duration:	90-120 minutes (per age group)
Number of participants:	All players
Description:	Session 1: - Anthropometry - Warm up - Motor Competence - Physical Fitness Session 2: - Psychological traits - Warm up - Skill Proficiency - Sports Participation History Questionnaire

Note:
This study has been approved by the University of Technology Sydney Human Ethics Committee (UTS HREC). If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat ph: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote UTS HREC: ETH16-0634. Any matters raised will be treated confidentially, investigated and you will be informed of the outcome.

Appendix 5: Organisation Consent Form

Dr Job Fransen
Sport and Exercise Science, Faculty of Health
Moore Park precinct
PO BOX 123 Broadway, NSW 2007 Australia
T: +61 2 9514 5203 | E: Job.Fransen@uts.edu.au

UTS

Organisation Consent Form for the Research Project:
A Multidimensional Approach to Talent Identification and Talent Development in Youth Sports

Dr Job Fransen, Professor Aaron Coutts, and Mr Kyle Bennett

Document Version 9: Dated 01/11/2016

I agree for my organisation, and players from my organisation, to participate in the above research project and give my consent freely.

I understand that the project will be conducted as described in the Organisation Information Statement, a copy of which I have retained.

I understand that my organisation, and players from my organisation, can withdraw from this research project at any time, without consequences, and without giving reason.

I consent to:

- My organisation assisting in recruiting players through:
  - Facilitating an information session hosted by the researchers to inform players and their parents/guardians about the research
  - Distributing the invitation to participate to eligible players and their parent's/guardians
- Helping the players from my organisation to participate in the assessment of anthropometry, motor competence, physical fitness, decision making ability and skill proficiency
- Assisting players from my organisation to fill out questionnaires on their previous sporting participation and psychological goal orientation

I understand that personal information relating to players from my organisation will remain confidential to the researchers and I have had the opportunity to have questions answers to my satisfaction.

Name: ____

Organisation: ____

Position: ____

Signature: ______________________________ **Date:** ________________

Note:
This study has been approved by the University of Technology Sydney Human Ethics Committee (UTS HREC). If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat ph: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote UTS HREC: ETH16-0634. Any matters raised will be treated confidentially, investigated and you will be informed of the outcome.

Appendix 6: Participant Information Statement

Dr Job Fransen
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PO BOX 123 Broadway, NSW 2007 Australia
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Information Statement for the Research Project:
A Multidimensional Approach to Talent Identification and Talent Development in Youth Sports

Dr Job Fransen, Professor Aaron Coutts, and Mr Kyle Bennett

Document Version 9: Dated 01/11/2016

Who is doing the research?
The research is being conducting as part of Mr Kyle Bennett's Doctor of Philosophy at the University of Technology Sydney. The research is supervised by Dr Job Fransen and Professor Aaron Coutts.

Why is the research being done?
The purpose of the research is to assess anthropometry, motor competence, physical fitness, decision-making, skill proficiency, psychology traits and previous sporting participation to see which of these factors influence the identification and development of 'talent' in youth sports. Further, this research would like to examine if the above variables are affected by the month of year that you were born in. Currently, there seems to be an overrepresentation of players born right after the cut-off date for their competitive age group.

Who can participant in this research?
We are looking for boys and girls between 8 and 18 years old from different individual and team sports. We encourage players of all levels and abilities to participate in this research, however it is important that if you have an electronic device inside your body (such as a pace maker) and you want to participate, this must be notified to the researchers through the signed informed consent form. Please also notify the researchers of any medical conditions that might prevent you from performing intense physical activity. If you are unable to perform physical activity with bouts of high intensity, unfortunately you will not be able to participate in this research.

What would you be asked to do?
If you agree to participate, you will be asked to perform a series low, moderate and high intensity tests where your anthropometry, motor competence, physical fitness, decision-making ability and skill proficiency will be assessed. Some of these assessments will be video-recorded. Feedback on these assessments will be provided to you. You may also choose whether this information can be shared with your club (there is an option for this on the consent form). You will also be asked to complete a questionnaire on your sports participation history and your psychological goal orientation. Your permission will be sought for the organisation to provide specific information about you to the researchers including: playing level (team); field position played during the year (if applicable); and attendance at training throughout the year. These assessments will be conducted on club grounds by trained researchers from the University of Technology, Sydney. Club officials will also be present at these sessions. The data obtained by the researchers during these activities will then be combined into a large dataset that will be used to assess the factors that may influence talent identification and development.

What choice do you have?
Participation in this research is entirely your choice. Only those people who give their informed consent will be included in the project. Players less than 18 years of age will also require parent/guardian consent to participate. Whether you decide to participate, your decision will not

disadvantage you in any way or affect your relationship with the club. If you do consent to participate, you may withdraw from the project at any time without giving a reason and have the option of withdrawing any data that identifies you.

How much time will it take?
The assessments for this project will be conducted over three to four sessions (decision-making: 30 minutes; skill proficiency: 60 minutes; and multidimensional: 2.5 hours) at your club. These same sessions will be repeated annually and everyone is encouraged to participate on each consecutive assessment. However, although encouraged, repeated participation over the duration of this study is not mandatory and anyone can withdraw participation at any time.

What are the risks and benefits of participating?
The assessment sessions in this project involve short bouts of highly intensity physical activity and lasts for a considerable time (up to 2.5 hours). Therefore, assessments may cause mild discomfort, muscular soreness and/or fatigue.

The benefit of participating in this project is that it allows participants to receive data on their 'growth areas' and 'talents' within their anthropometry, motor competence, physical fitness, decision-making, skill proficiency, psychological traits and their previous sports participation. This may help participants optimize their development within their current sport. Although the interpretation of data collected in this project is used to provide the participants with help in pursuing their development within their sport of choice, a simple representation of these data will also be accessible to the clubs if permission is granted. While clubs may wish to use this data to assist them in supporting player's 'growth areas' and 'talents', clubs are strongly discouraged from using this information to assess athletics career progression.

How will your privacy be protected?
The information collected by the researchers which might identify you will be stored securely and only accessed by the researchers unless you consent otherwise, except as required by law. These data will be retained for at least 5 years at the University of Technology Sydney for research conducted by University staff and students, and any personal identifiers within this data set will be replaced by anonymous identification numbers.

How will the information collected be used?
The information collected by the researchers will be used to write articles that will be published in scientific journals and will also contribute to the Mr Kyle Bennett's research thesis. However, in these outcomes, individual participants will not be identified. Some of the data collected in this project will include video capture. However, you will be able to review the recording to edit our erase your contribution if you wish to do so. Upon completion of assessments, data will be recorded on individual data sheets that will be provided to the participants. At the end of the project, a summary of the overall outcome of the research will be provided to clubs. Participants may request a copy of this either from their club or directly from the researchers.

What do you need to do to participate?
Please read this Information Statement and be sure you understand its contents before you consent to participate. If there is anything you do not understand, or you have questions, contact the research team using the contact details heading of this letter. If you would like to participate, please complete the attached informed consent form. Participants less than 18 years of age will also require their parent/guardian's consent. If you require any further information, an information session can be organised by your club with the research team to outline this project in further detail. If you agree to participate, researchers will contact you through your club about the time and date of the assessment session. Note to parents/guardians: If you are providing consent for a child or young person less than 18 years of age, please discuss the project with them before deciding. Where a parent/guardian has provided consent, the final decision regarding participation will rest with the child/young person.

Further information
If you would like further information, please contact Dr Job Fransen at Job.Fransen@uts.edu.au or at +61 2 9514 5203; or Mr Kyle Bennett at Kyle.J.Bennett@student.uts.edu.au.

Thank you for considering this invitation.

Job Fransen
Lecturer
University of Technology Sydney

Kyle Bennett
PhD Student
University of Technology Sydney

Note:
This study has been approved by the University of Technology Sydney Human Ethics Committee (UTS HREC). If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat ph: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote UTS HREC: ETH16-0634. Any matters raised will be treated confidentially, investigated and you will be informed of the outcome.

Appendix 7: Participant Consent Form

Dr Job Fransen
Sport and Exercise Science, Faculty of Health
Moore Park precinct
PO BOX 123 Broadway, NSW 2007 Australia
T: +61 2 9514 5203 | E: Job.Fransen@uts.edu.au

Participant Consent Form for the Research Project:
A Multidimensional Approach to Talent Identification and Talent Development in Youth Sports

Dr Job Fransen, Professor Aaron Coutts, and Mr Kyle Bennett

Document Version 9: Dated 01/11/2016

I agree to participate in the above research project and give my consent freely.

I understand that the project will be conducted as described in the Information Statement, a copy of which I have retained.

I understand that I am free to withdraw my participation from this research project at any time, without consequences, and without giving reason.

I agree that I am free of any electronic implants or medical conditions that may prevent me from performing any physical activity with bouts of high intensity. If I do have any electronic implants or medical conditions I have notified the researchers accordingly: ___________________________

I consent to:

- (i) Participate in assessment of anthropometry, motor competence, physical fitness, decision-making and skill proficiency
- (ii) Complete questionnaires on my previous sporting participation and psychological goal orientation
- (iii) My club providing information to researchers regarding my playing level, field position and training status

I agree to my data being provided to my club: Yes or No (Please Circle One)

Player Name: ____

Club Name: ____

Player Signature: ______________________________________ **Date:** ______________________

Parent/Guardian Consent (For Participants < 18 years)

Parent/Guardian Name: ____

Parent/Guardian Signature: ___________________________________ **Date:** _______________

Note:
This study has been approved by the University of Technology Sydney Human Ethics Committee (UTS HREC). If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat ph: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote UTS HREC: ETH16-0634. Any matters raised will be treated confidentially, investigated and you will be informed of the outcome.

Appendix 8: Participation History Questionnaire

1. 'Milestones'

What is your full name? ____

What is your date of birth? ____

What is your town/city of birth? ____

How old were you when you started:

i) Primary school? ____

ii) Secondary school? ____

What town/city did you go to:

(i) Primary school? ____

(ii) Secondary school? ____

What was the name of your:

(i) Primary school? ____

(ii) Secondary school? ____

Sports-specific (If you haven't completed any of the following please circle not applicable)

I was ___ years old when I first started playing soccer (not in organised competition) N.A.

I was ___ years old when I first took part in supervised training with an adult in soccer N.A.

I was ___ years old when I first began regular soccer training N.A.

I was ___ years old when I first played in an organised competition match N.A.

I was ___ years old when I first began non-soccer training (e.g. strength) regularly N.A.

I was ___ years old when I first participated at an <u>academy</u> level N.A.

I was ___ years old when I first competed at a <u>state</u> level N.A.

I was ___ years old when I first competed at a <u>national</u> level N.A.

I was ___ years old when I competed at an <u>international</u> level N.A.

2. Engagement in Soccer-related activities

The following section focuses on the soccer-related activities you have participated in from when you began playing to the present day, the number of hours spent in these activities per week, and the number of months per year you spent in each of the activities. This will be done for each year you have participated.

Please group the activities you have participated in into the categories listed below:

1. Match-play: organised competition in a group engaged in with the intention of winning and supervised by adult(s), e.g. soccer match.

2. Coach-led group practice: organised group practice engaged in with the intention of performance improvement and supervised by coach(es) or adult(s), e.g. practice with team.

3. Individual practice: practice alone engaged in with the intention of performance improvement, e.g. practicing passing skills alone.

4. Peer-led play: play-type games with rules supervised by yourself/peers and engaged in with the intention of fun and enjoyment, e.g. game of soccer in the park with friends.

On the next page there is 'participation history' log, which lists these four categories and groups them into years. Please fill this in as accurately as possible, starting from the last season you played (2016) and working downwards until you have completed the first year you played soccer. Please do not fill in shaded areas.

For each year, please complete:

i) The total number of hours spent taking part in activities related to each category.

ii) The number of months of the year that you spent taking part in activities related to each category.

iii) The number of weeks from the relevant year that you were injured and unable to take part in the soccer activity. Leave blank if no injury.

Note:
Please write the name of the coach and the team you played for in each season in the space provided. A soccer season equals the total months including pre-season, trial matches and competition matches. This will vary depending on the competition level you participated in.

Age group	Team and Coach	Activities	# of hrs/wk	Months /yr	Injury wks/yr
e.g.	John Smith Northern Suburbs RFC	1. Match-play	2	9	3
		2. Coach-led practice	6	9	
		3. Individual practice	2	12	
		4. Peer-led play	5	12	
U/18		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			
U/17		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			
U/16		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			
U/15		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			
U/14		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			
U/13		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			
U/12		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			
U/11		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			
U/10		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			

U/9		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			
U/8		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			
U/7		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			
U/6		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			
U/5		1. Match-play			
		2. Coach-led practice			
		3. Individual practice			
		4. Peer-led play			

Categories:

1. Match-play: organised competition in a group engaged in with the <u>intention of winning</u> and supervised by adult(s), e.g. soccer match.

2. Coach-led group practice: organised group practice engaged in with the <u>intention of performance improvement</u> and supervised by coach(es) or adult(s), e.g. practice with team.

3. Individual practice: practice alone engaged in with the <u>intention of performance improvement</u>, e.g. practicing dribbling skills alone.

4. Peer-led play: play-type games with rules supervised by yourself/peers and engaged in with the <u>intention of fun and enjoyment</u>, e.g. game of soccer in park with friends.

3. Engagement in other sport activities

The following section focuses on the other sporting activities you have engaged in, the period of your life in which you took part in this activity, the number of hours per week, and months per year spent in these activities, and the standard of this activity. For each activity:

i) Please place a tick next to the other sports that you have participated in during your life, <u>outside of timetabled school physical education classes</u>.

ii) The age you <u>started</u> taking part in each activity.

iii) The age you <u>finished</u> taking part in each activity (if you are still participating then leave this blank).

iv) The total number of hours per week spent taking part in each activity.

v) The number of months of the year in which you took part in each activity.

vi) The standard of the activity that you took part in for that sport (e.g., school, club, national, international).

Note:
Please only record other sport activity that has lasted a minimum of three months of activity.

Other Sport Activities	Please tick (if yes)	Start Age	Finish Age	# of hrs/wk	Months /yr	Playing Standard
e.g. Cross country	✓	7	12	2	8	School
Athletics						
Badminton						
Basketball						
Boxing/Kick boxing						
Canoeing						
Cricket						
Cycling						
Cross Country						
Gymnastics						
Golf						
European Handball						
Hockey						
Judo/Karate						
Rugby League						
Snooker/Pool						
Swimming						
Skiing/Snowboarding						
Stretching/Yoga/Pilates						
Table tennis						
Tennis						
Volleyball						
Resistance Training						
Other:						
Other:						
Other:						
Other:						
Other:						

Appendix 9: Task and Ego Orientation in Sport Questionnaire

Player Name: ____________________

Age Group: ____________________

Consider the statement "**I feel most successful in sport when …**" and read each of the following statements listed below. Indicate how much you personally agree with each statement by circling the appropriate score where:

"1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree"

	Question	**Please circle one response**				
1	I am the only one who can do the play or skill	1	2	3	4	5
2	I learn a new skill and it makes me want to practise more	1	2	3	4	5
3	I can do better than my friends	1	2	3	4	5
4	The others cannot do as well as me	1	2	3	4	5
5	I learn something that is fun to do	1	2	3	4	5
6	Others mess up and I do not	1	2	3	4	5
7	I learn a new skill by trying hard	1	2	3	4	5
8	I work really hard	1	2	3	4	5
9	I score the most points/goals/hits etc.	1	2	3	4	5
10	Something I learn makes me want to go practise more	1	2	3	4	5
11	I am the best	1	2	3	4	5
12	A skill I learn really feels right	1	2	3	4	5
13	I do my best	1	2	3	4	5