COULD SPORTS BIOMECHANICS PROVIDE THE MISSING PIECES TO THE TALENT IDENTIFICATION AND DEVELOPMENT PUZZLE?

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Introduction

Over the past 40 years, an increasing number of sports organisations from around the world have adopted talent identification (TI) and talent development (TD) programmes (collectively TID) to help uncover and nurture the next generation of sporting superstars. Professional sports clubs, national governing bodies, high-performance agencies, elite training institutes, and youth development academies, most notably in Australia, the United Kingdom, the United States of America, China, and Qatar, now routinely implement TID programmes in the belief that, by identifying young individuals with sporting potential early, these fledgling prospects can engage in, and accumulate, the 10 years or 10,000 hours of ‘deliberate practice’ (i.e., highly structured, goal-directed, and effortful activity) thought to be a prerequisite for expert performance in sport (see Ericsson, Krampe, & Tesch-Römer, 1993; Gladwell, 2008). Recently, however, the efficacy of TID programmes has come under scrutiny because, not only do these initiatives have a strong tendency to encourage early specialisation, which may actually hinder progression towards the attainment of sporting excellence by contributing to the development of physical (e.g., overuse injuries) and psychosocial (e.g., burnout, dropout) issues (e.g., Baker, 2003; DiFiori et al., 2014; Feeley, Agel, & LaPrade, 2016), they also typically have a weak scientific basis and lack a sound theoretical rationale, resulting in them having questionable validity and, ultimately, limited predictive power (e.g., Abbott & Collins, 2002; Vaeyens, Lenoir, Williams, & Philippaerts, 2008).

Another reason why TID programmes may not have had the impact they were intended to have is a lack of coverage from the subdiscipline of sports biomechanics. The omission of a formal biomechanics component from the vast majority of TID programmes appears to be a major shortcoming of these initiatives, especially given that, in many sports, one of the strongest indicators of ‘talent’ is perhaps the technical proficiency with which motor skills integral to those sports are performed. Biomechanics has also been conspicuously absent from almost all scientific discourse on TID in sport (although see Cooke, 2008, for an isolated effort). Although
motor/technical skill has featured in schematics of TID in the sport science literature (e.g., see figure 3 of Williams & Reilly, 2000), the facilitative role of biomechanics in the TID process has rarely been considered. Applied empirical studies investigating the biomechanics of sports techniques have occasionally made reference to how results could have ramifications for TID (e.g., Worthington, King, & Ranson, 2013), but, on closer inspection, these claims often prove to be less than convincing. Davids, Lees, and Burwitz (2000) made a number of potentially impactful recommendations about the role biomechanics – supported by contemporary motor control theory – could play in enhancing the understanding of processes of coordination and control in kicking skills, which they suggested could have implications for TID programmes in football (soccer), but, to date, these ideas have not been developed further nor have they been extrapolated and applied to other sports involving similar multiarticular or multijoint actions.

In this chapter, I examine some of the main issues that have prevented biomechanics from occupying a more central role in TID in sport and discuss if, and how, these impediments may be overcome. I begin, however, by critically examining how technical skill has been assessed in TID programmes adopted by different sports organisations and scientific investigations of TID in sport, before arguing a case for the inclusion of a biomechanical component. As there is now a plethora of excellent texts on biomechanical data collection methods and procedures (e.g., Payton & Bartlett, 2008; Robertson, Caldwell, Hamill, Kamen, & Whittlesey, 2013; Winter, 2009), the theory and practice of capturing valid and reliable kinematic, kinetic, and electromyographic data will not be covered here. Interested readers are also directed to Wade and Berg (1991) and Knutzen and Martin (2002) for special consideration of biomechanical measurement issues specifically related to the study of movement in children.

**TID in sport: How is technical skill assessed?**

Many TID programmes adopted by professional sports clubs have been based on the subjective assessment of factors that are intuitively associated with expert performance in that sport. Technical skill has featured prominently in these assessments alongside other factors such as athleticism, personality, and game intelligence, and in football, for example, these factors have been expressed as acronyms, such as TIPS (Technique, Intelligence, Personality, Speed), TABS (Technique, Attitude, Balance, Speed), SUPS (Speed, Understanding, Personality, Skill), and PAS (Pace, Attitude, Skill) (see Reilly, Williams, & Richardson, 2008). The evaluation of prospective talent against prespecified criteria is usually undertaken by experienced coaches or talent scouts who observe behaviour during formal trials or competitive matches. Although the perceptual abilities of these expert observers should not be underestimated (see the penultimate section of this chapter for a discussion on visual expertise in the perception of action), it is possible that their assessments could be prejudiced by their personal beliefs and opinions about what constitutes ‘good technique’, thereby potentially introducing bias into the process.

A similar approach has also been adopted by some national governing bodies. For example, in the TI stage of the ‘England Cricket Pathway’ devised by the England and Wales Cricket Board, schools and clubs nominate promising 9- to 11-year-olds to represent their district and county having shown potential during competitive matches. Again, subjective assessment of technique, amongst other factors, appears to be the main method of identifying talented children, although performance indices, such as runs scored and wickets taken, are also considered. More formal skills testing, in the guise of the ‘England Development Programme Talent Test’, only occurs, for the first time, at around 12 years of age for those children nominated by their county academy coach. For seam and spin bowlers, these skills tests involve bowling at different areas or ‘scoring zones’ of the pitch at top pace and imparting as many revolutions on the
ball at release as possible whilst maintaining accuracy, respectively. For batters, skills tests involve batting against different speeds of bowling using a narrower than standard bat.

High-performance agencies, often in partnership with elite training institutes (e.g., UK Sport/English Institute of Sport), have implemented more objective tests in their TID or ‘performance pathway’ programmes. However, owing to the large numbers of potentially talented young adults that present themselves for screening during talent search campaigns, and the diverse requirements of the Olympic and Paralympic sports being recruited for (e.g., rowing, volleyball, skeleton), these tests have tended to be simplistic and somewhat generic in nature, and have typically focused on the collection of anthropometric (e.g., stature, mass, body composition, limb lengths and girths, etc.), physical (e.g., speed, strength, flexibility, etc.), and physiological (e.g., anaerobic and aerobic power, etc.) variables thought to be strong indicators of sporting potential (Gulbin & Ackland, 2009). Technical skill tests have not routinely been implemented, presumably due to this aspect of sports performance being more difficult and time-consuming to assess objectively, and because it is thought that, in most sports being recruited for, technical skill can be developed at a later date with intensive training and specialist coaching providing the basic physical and physiological attributes exist.

The assessment of technical skill has also been inconsistent in scientific investigations of TID in sport. Most empirical studies have tended to focus on anthropometric, physical, physiological, and, to a lesser extent, psychological variables, either in isolation or in combination, with comparatively few attempting to assess technical skill. In the studies that have considered this aspect of sports performance (e.g., Pienaar, Spamer, & Steyn, 1998; Reilly, Williams, Nevill, & Franks, 2000; Keogh, Weber, & Dalton, 2003; Gabbett, Georgieff, & Domrow, 2007), the tests used have typically been simplified versions of tasks integral to the performance of that sport, and the measures produced have been, almost exclusively, outcome-focused. For example, Reilly et al. (2000) used the slalom dribbling and shooting tests summarised in Figure 17.1 to assess talent in young football players. These tests are limited, however, because, not only do

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**Figure 17.1** Two tests for assessing technical skill in football. In the slalom dribbling test (left), participants are required to dribble the ball between a series of cones, predominantly in a zigzag path, as quickly as possible. In the shooting test (right), participants are required to repeatedly shoot at goal and score as many points as possible (see Reilly & Holmes, 1983, for a full description). These, and other similar, tests have been routinely used in football and other field sports (e.g., hockey) to assess technical skill.
they remove important perceptual information (e.g., the movements of opponents and team-mates) that footballers couple their movements to during competitive matches (i.e., they lack ‘task representativeness’; see Phillips, Davids, Renshaw, & Portus, 2010; Vilar, Araújo, Davids, & Renshaw, 2012) and provide no information about the techniques used to perform these tests, their results can be substantially influenced by growth and maturation with physically stronger, more powerful, children able to complete the dribbling task quicker and potentially be more accurate with their shots (see Ali, 2011, for a further critique of skills tests used to assess football performance).

To summarise, there are several issues surrounding technical skill assessments used in TID programmes and scientific investigations of TID in sport. These include: the inconsistent application of skills tests across different sports; the potential bias associated with subjective assessments of technical skill; the lack of ‘task representativeness’ of some skills tests; the confounding effects of physical maturity on outcome measures; and the lack of information provided about the underlying movement patterns that produce the outcomes. In the next section, I examine the role sports biomechanics could have in identifying and developing technical skill in potentially talented young athletes and why it has seldom been used in a TID context previously, before discussing, in the penultimate section of this chapter, what needs to be done to increase the application and utility of sports biomechanics in TID in sport in the future.

Identifying and developing technical skill in sport: Could sports biomechanics have a role?

The two main aims of sports biomechanics are generally accepted to be the enhancement of sports performance and the reduction of injury risk through the improvement of technique (Bartlett & Bussey, 2012). As one of the goals of TID is to nurture efficient, effective, and safe sports techniques, it would appear, in principle, that sports biomechanics could make a useful contribution to this aspect of TID. Furthermore, given that a necessary prerequisite for developing talent from a biomechanical perspective would appear to be having knowledge about the movement patterns or, more specifically, the coordination and control patterns that characterise efficient, effective, and safe sports techniques, it is possible that this knowledge could, in principle, be used as a basis for TI. Why, then, has sports biomechanics seldom been used in a TID context previously?

Apart from the prohibitive cost of biomechanical analysis equipment and the specialist technical expertise required to operate it, perhaps the main reason why sports biomechanics has not occupied a central role in TID in sport is the lack of consensus about what constitutes an efficient, effective, and safe technique in many sports. A tacit assumption held by many coaching practitioners is that there is one ‘best’ or ‘optimal’ technique for each sport usually the one advocated in the coaching textbook or exemplified by a champion athlete that all performers should aspire to achieve and coaches can use for comparative purposes to identify faults and prescribe modifications (e.g., Sherman, Sparrow, Jolley, & Eldering, 2001; Irwin, Hanton, & Kerwin, 2005; Jones, Bezodis, & Thompson, 2009). Although this perspective may be tenable in sports such as gymnastics where the task goal often dictates what movement patterns must be adopted, or in sports such as cycling and rowing where movement patterns are greatly constrained by the need to mechanically anchor the pelvis and limbs to the apparatus used, it is perhaps less useful in sports where rules and equipment place no, or very few, restrictions on limb and torso movements. Indeed, as the richness and diversity of techniques exhibited by elite sports performers in different sports can attest, it is possible to deviate quite markedly from a putatively ‘ideal’ movement pattern and still be successful in achieving the task goal (Cavanagh, 1987).
What inferences can be drawn from the scientific literature about the biomechanical characteristics that define efficient, effective, and safe sports techniques? Owing to the experimental paradigms commonly adopted in applied sports biomechanics research, many investigations have only provided very limited information about isolated aspects of sports techniques that are thought to be related to performance and injury. To illustrate some of the main issues and how they impact on the capacity of applied sports biomechanics research to identify efficient, effective, and safe sports techniques for TID purposes, consider the scientific literature on the biomechanics of cricket fast bowling techniques (Glazier & Wheat, 2014). Fast bowling provides an excellent task vehicle for this discussion because a biomechanically ‘correct’ technique is generally considered to be a prerequisite for producing fast and accurate deliveries and for reducing the likelihood of sustaining lower back injuries, which have been, and continue to be, highly prevalent in aspiring adolescent and young adult fast bowlers (e.g., Johnson, Ferreira, & Hush, 2012). Fast bowling is also one of the few sports skills where sports biomechanists have claimed that biomechanical analyses have been able to make a substantive contribution to the enhancement of technical knowledge by establishing statistical associations between aspects of technique and performance and injury (see Bartlett, 1997, and Elliott & Bartlett, 2006, for commentaries).

**How useful is biomechanical information for TID in sport? A cricket fast bowling example**

In performance-related biomechanical studies of fast bowling, a common empirical approach has been to correlate time-discrete kinematic variables obtained during the delivery stride (see Figure 17.2 for a description of the key moments and constituent phases of the delivery stride) with ball release speed in a single homogenous skill-level group of fast bowlers (e.g., Glazier, Paradisis, & Cooper, 2000; Loram et al., 2005; Wormgoor, Harden, & McKinon, 2010; Ferdinands, Kersting, & Marshall, 2013). Worthington et al. (2013) extended this correlation approach and used stepwise linear regression to identify four time-discrete kinematic variables that accounted for approximately three-quarters of the variation in ball release speed in a group of young elite fast bowlers. In partial agreement with previous investigations, this study found that the fastest bowlers had a quicker run-up, maintained a straighter front knee and had larger amounts of upper trunk flexion during the front foot contact–ball release (FFC-BR) phase, and delayed the onset of bowling arm circumduction. It was suggested that these results were likely to be useful in a TI context but no further elaboration was provided.

![Figure 17.2](image)

*Figure 17.2* Key moments during fast bowling: back foot contact (BFC); front foot contact (FFC); and ball release (BR). The delivery stride is defined as the period between BFC and BR. Images sampled at 20 millisecond intervals.
In injury-related biomechanical studies of fast bowling, a common empirical approach has been to compare mean values of time-discrete kinematic variables obtained during the delivery stride for a sample of fast bowlers retrospectively divided into two or more groups based on injury status (e.g., Foster, John, Elliott, Ackland, & Fitch, 1989; Elliott, Hardcastle, Burnett, & Foster, 1992; Portus, Mason, Elliott, Pfitzner, & Done, 2004). One of the most significant findings to emerge from these studies is that a 'mixed' bowling action, which is characterised by a realignment or counter-rotation of the thorax to a more side-on orientation during the back foot contact–front foot contact (BFC–FFC) phase, has consistently been associated with the occurrence of abnormal radiologic features in the lumbar spine. This finding has profoundly influenced TD in fast bowling over the past 20 years, with many coaching practitioners attempting to minimise the amount of thorax counter-rotation and thereby reduce the incidence of debilitating lower back injuries in adolescent and young adult fast bowlers (see Elliott & Khangure, 2002).

Although these applied studies have provided some useful insights into the biomechanical factors associated with performance and injury in fast bowling, it could be argued that their practical application and utility in a TID context is somewhat limited. Based on their collective findings, it may be concluded that young fast bowlers who have a fast run-up, minimal thorax counter-rotation, delayed bowling arm circumduction, and a straight front knee, and a more flexed upper trunk, at BR, should be targeted in TI programmes as these characteristics have been linked to high ball release speeds and reduced risk of lower back injury. However, group-based research designs only permit probabilistic ‘in general’ or ‘on average’ statements being postulated and tend to mask individual differences (see Bouffard, 1993; James & Bates, 1997; Mullineaux, Bartlett, & Bennett, 2001). It is quite feasible, then, that aspiring young fast bowlers may not demonstrate some, or any, of these technical characteristics but still perform to a high level and remain injury free. Indeed, there are many examples of elite fast bowlers who do not display all of these technical characteristics, such as Dennis Lillee and Jeff Thomson, the great Australian duo, who exhibited moderate front knee flexion during the FFC-BR phase and a comparatively slow run-up speed, respectively (Penrose, Foster, & Blanksby, 1976).

A similar problem arises when attempting to apply the results of a group-based analysis to specific individuals in a TD context. Based on the aforementioned findings, it may be concluded that, to improve performance and reduce injury risk in fast bowling, a given fast bowler should attempt to increase run-up speed, minimise thorax counter-rotation, delay bowling arm circumduction, and straighten their front knee, and flex their upper trunk more, at BR. However, caution needs to be applied when interpreting group-based results in this way because, as Bouffard (1993) explained, ‘propositions about people cannot necessarily be derived from propositions about the mean of people because the patterns found by aggregating data across people do not necessarily apply to individuals’ (p. 371). Indeed, there have been several well-documented cases of elite international fast bowlers, such as James Anderson and Liam Plunkett, who were encouraged to modify their actions based on findings obtained from scientific studies only to lose form and sustain injuries to their lower backs. Only after reverting back to their old, more ‘natural’, techniques did they recapture previous performance levels, remain relatively injury free, and, in the case of Anderson, become the leading wicket-taker in Test matches for England.

A further issue that compromises the capacity of applied sports biomechanics research to identify efficient, effective, and safe fast bowling techniques for TID purposes is that many studies, paradoxically, do not analyse ‘technique’, which Lees (2002) defined as ‘the relative position and orientation of body segments as they change during the performance of a sport task’ (p. 814, my emphasis). The almost exclusive use of time-discrete kinematic measurements provides, at
best, only snapshots of ‘technique’ and offers very limited information about the underlying patterns of coordination and control (see Glazier, Davids, & Bartlett, 2003; Glazier, Wheat, Pease, & Bartlett, 2006; Glazier & Robins, 2012). For example, it has been shown that the maximum angular velocities of the pelvis and thorax in the transverse plane are both significantly associated with ball release speed (Ferdinands et al., 2013), but this analysis provides no information about how the pelvis and thorax interact with each other or how these two segments interact with preceding and succeeding segments in the kinematic chain to effectively transfer energy and momentum to maximise ball release speed (see Glazier & Wheat, 2014, for further discussion of these issues). Similarly, the reporting of maximum counter-rotation of the thorax during the BFC-FFC phase provides no information about how the pelvis and thorax interact, particularly in the transverse and coronal planes during the FFC-BR phase, which has recently been postulated as a more likely contributory factor to lower back injuries in fast bowlers (e.g., Ranson, Burnett, King, Patel, & O’Sullivan, 2008; Glazier, 2010; Bayne, Elliott, Campbell, & Alderson, 2016).

To summarise, the main aims of sports biomechanics suggest that this subdiscipline of sports science could make an important contribution to TID in sport but the experimental paradigms habitually used in sports biomechanics research currently prevent it from doing so. Although cricket fast bowling has been used here as an exemplar task vehicle, many of the issues highlighted apply to other extant studies on multiarticular actions in sport (see Glazier, Reid, & Ball, 2015). In the penultimate section of this chapter, I underscore the importance of analysing coordination and control in sports skills and its potential significance in TID in sport.

Analysing coordination and control of sports skills: Why is it important and what does it mean for TID in sport?

So far in this chapter, I have described how technical skill has been assessed in TID programmes adopted by different sports organisations and in scientific investigations of TID in sport, and I have proposed that sports biomechanics could have a role in identifying and developing technical skill. To increase the application and utility of sports biomechanics in TID, however, it is recommended that a more process-focused, as opposed to outcome-focused, approach is adopted to gain a better understanding of the underlying patterns of coordination and control that may characterise efficient, effective, and safe sports techniques.

Although the terms ‘coordination’ and ‘control’ are often used interchangeably by coaching practitioners when assessing sports techniques (e.g., ‘that movement was well coordinated/controlled’), they have distinct meanings in the scientific literature. Based on the framework outlined by Newell (1985), coordination can be operationally defined as the spatiotemporal relationship among body segments, limbs, or limbs and torso, whereas control refers to the absolute magnitude of individual limb, or limb and torso, segment movements. Coordination can be characterised by the topology (shape or form) of the relative motion of the body segments or limbs (i.e., the motion of one body segment or limb with respect to the motion of another body segment or limb), whereas control, which is a product of the tuning, scaling, or parameterisation of this relative motion, can be characterised by the linear and angular kinematics (displacement, velocity, acceleration) and kinetics (force, torque, energy, momentum) of a particular body segment or limb (see Sparrow, 1992). Importantly, coordination precedes control (Meijer, 2001) because coordination is the organisation of the control of the motor apparatus (Bernstein, 1967). Figure 17.3 provides further clarification of the distinction between coordination and control, and how they are related, using the motions of limb and torso segments during the performance of a golf swing as a vehicle for this discussion.
In terms of TI, a significant task for sports biomechanists is to identify the patterns of coordination and control that characterise efficient, effective, and safe techniques in different sports against which the techniques of young athletes can be compared. As discussed earlier in this chapter, the amount of variability exemplified in the techniques of elite performers makes this task challenging, particularly if experimental paradigms commonly adopted in applied sports biomechanics research continue to be implemented. Until more robust criteria about what patterns of coordination and control characterise efficient, effective, and safe techniques are established, it may be expedient to use the patterns of coordination and control that are deemed to be harmonious with a mechanically sound technique, such as those described in coaching manuals or exhibited by certain elite performers, as a template on which to base TI. Taken at face value, this proposition may seem at odds with assertions made in the scientific literature questioning the efficacy of ‘common optimal movement patterns’ in skill acquisition and sports biomechanics (e.g., Brisson & Alain, 1996; Davids, Glazier, Araújo, & Bartlett, 2003; Seifert, Button, & Davids, 2013) and thus may be considered somewhat contentious. However, if already established patterns of coordination and control approximate those proven to be effective at the highest level of competition, this approach could be useful in helping to identify talented athletes in certain sports. Indeed, it has been proposed that the close fit between pre-existing coordination and control tendencies (intrinsic dynamics) and those required for the successful completion of a particular task (task dynamics) may explain precocious talent in sport, where young athletes are able to achieve performance excellence at an early age despite receiving limited coaching and/or engaging in minimal practice (e.g., Davids, Button, & Bennett, 2008; Chow, Davids, Button, & Renshaw, 2016).

Figure 17.3 As in many other multiaxial throwing, kicking, and hitting actions where the distal-most body segment or hitting implement is required to move at high speed at impact or release, the generation of clubhead speed during the golf swing occurs through a precisely timed sequence of body segment rotations that generally occur in a proximal to distal order. The peak rotational speed of each segment in this linked-segment system or kinematic chain is greater, and occurs closer to impact, than the peak rotational speed of the preceding body segment (left). The amount of energy and momentum transferred between two adjacent body segments (e.g., pelvis → thorax) is dependent on their coupling relationship or relative motion (right), which can be varied according to the amount of clubhead speed required to hit the ball to the target.
A further advantage of analysing patterns of coordination and control is that it has been suggested that these aspects of technique may be perceived by coaching practitioners, and athletes themselves, when making subjective assessments about technique (Newell, 1985; Scully & Newell, 1985; Sparrow & Sherman, 2001). Indeed, research on the visual perception of biological motion has demonstrated that observers tend to use relative, as opposed to common, motion of torso and limb segments as their primary source of information (see Scully & Newell, 1985, for a review and discussion of the wider implications for the ‘observational learning’ of motor skills). In the second section of this chapter, I identified that one of the criticisms often aimed at many TID programmes is that they rely too heavily on subjective evaluation of technique. However, not only is it quite possible that experienced coaches and talent scouts are already highly adept at being able to tacitly identify putatively desirable patterns of coordination and control exemplified by young athletes (i.e., they have a ‘good eye’ for skilful athletes), it may also be possible to improve the observational skills of less experienced TID personnel. In this way, relative motion information about the coordination and control of sports skills could, in effect, provide a common language with which sports biomechanists, coaching practitioners, and talent scouts can use in their collaborative efforts to identify talented young athletes.

A potentially significant issue that threatens to undermine the efficacy of analysing patterns of coordination and control in TI, however, is the oftentimes rapid changes in key organismic constraints during growth and maturation. As it is now well-established that organismic constraints, in conjunction with environmental and task constraints, act to shape patterns of coordination and control (e.g., Newell, 1986; Araújo, Davids, Bennett, Button, & Chapman, 2004; Glazier & Robins, 2013), any changes in anatomical, morphological, and neurophysiological constraints during periods of accelerated growth are likely to have an impact on technique. One particularly influential morphological constraint is the moment of inertia (MOI) of limb and torso segments (Newell, 1984). The MOI of a body segment represents its resistance to angular acceleration and is the product of its mass and the square of its radius of gyration. To maintain patterns of coordination and control during a growth spurt, any increases in the MOI of body segments need to be matched by concomitant increases in torques produced about the active joints. However, the development of muscular strength typically lags behind increases in MOI of body segments, which has a disequilibrating effect that can destabilise patterns of coordination and control leading to reduced motor performance (Jensen, 1981). So, even though desirable patterns of coordination and control may be identifiable during the prepubescent years, it is far from clear whether they will be maintained during puberty or, if they are ‘lost’, whether they can be regained during adolescence.

In terms of TD, the role of sports biomechanics is to improve the efficiency, effectiveness, and safety of patterns of coordination and control. Whereas comparing patterns of coordination and control that are already established with a mechanically sound model of technique may be a useful strategy for TI, forcing young athletes to approximate the same criterion pattern of coordination and control in an attempt to improve performance and reduce injury risk is ill-advised since organismic constraints can vary considerably between individuals (Brisson & Alain, 1996). One of the main impediments to enhancing sports techniques from a biomechanical perspective is the inability of sports biomechanists to identify athlete-specific optimal techniques in a range of sports (see also Newell & Walter, 1981; Newell & McGinnis, 1985). As already discussed, the experimental paradigms adopted in many applied sports biomechanics studies tend to provide only generalised recommendations, which often have little relevance to facilitating the development of efficient, effective, and safe sports techniques at the individual level. Other statistical and mathematical modelling approaches that have been promoted in the
sports biomechanics literature have similar pitfalls. For example, the practice of averaging kine-
matics across elite performers to establish a normative technique profile (e.g., Mann & Griffin,
1998; Ae, Muraki, Koyama, & Fujii, 2007; Ae, 2008), in effect, perpetuates the view that inter-
individual variability represents error or noise and should, therefore, be removed, and the
generation of putatively individual-specific optimal sports techniques using computer simul-
ation (e.g., Yeadon & King, 2008; King & Yeadon, 2015) often fails to capture the richness and
diversity of techniques exhibited by elite sports performers owing, in large part, to mathemat-
ical models of human performers being under-constrained (Glazier & Davids, 2009).

Given that it is not yet possible to objectively identify athlete-specific optimal techniques
for different sports and, therefore, criterion templates to help identify faults and prescribe modi-
fications cannot yet be established, other approaches to skill enhancement need to be explored.
The application of ‘biomechanical principles of movement’ (see Lees, 2002, for an elaboration),
may facilitate the development of efficient, effective, and safe patterns of coordination and
control in young athletes. However, rarely have these principles been subjected to rigorous
empirical verification and, on occasions when they have, some have been found to be invalid
(e.g., Glazier & Worthington, 2014), whereas others have only been shown to be valid for
certain movements and tasks (e.g., Fradet et al., 2004). A potentially more effective approach
might be to use biomechanical measurements as augmented information to channel the devel-
oping athlete’s search towards his or her own optimal movement solution (e.g., Newell, Kugler,
van Emmerik, & McDonald, 1989). In golf, for example, shot outcome is directly related to
initial launch parameters, which are, in turn, directly related to club delivery parameters (see
Tuxen, 2009). However, since different patterns of coordination and control can produce the
same club delivery parameters, it is difficult to predict whether a prescribed technical change
will lead to improved club delivery for a particular golfer and, if it does, whether this techni-
cal adjustment can be reliably performed. To counter this issue, a viable pedagogic strategy
might be to manipulate physical and instructional constraints and observe how club delivery
parameters (e.g., club speed, swing path, attack and face angle, dynamic loft, etc.), which can be
readily measured using launch monitor technology, change with the intervention. Once more
desirable club delivery parameters have been achieved, the developing golfer can attempt to
iteratively recreate the pattern of coordination and control that produced those more desirable
club delivery parameters. This form of ‘guided discovery learning’ (see Handford, Davids,
Bennett, & Button, 1997) has been shown to improve performance in some sports (e.g.,
Vereijken & Whiting, 1990) and could be instrumental in helping to develop more efficient,
effective, and safe techniques in many others.

Concluding remarks

This chapter has provided a very rare exposition of the potential role of biomechanics in TID
in sport. Although it is too early to definitively answer the question posed in the title of this
chapter, based on the arguments presented above, I speculatively suggest that sports biome-
chanics could make a valuable contribution to the identification and development of talent in
sport but greater attention needs to be given to identifying the underlying patterns of coordi-
nation and control that characterise efficient, effective, and safe sports techniques. Further
research is required to establish what biomechanical characteristics define expert sports
performance and how changes in organismic (e.g., anatomical, morphological, neurophysio-
logical) constraints associated with physical maturation and growth impact on the coordination
and control of sports techniques. This research would benefit from adopting an interdiscipli-
nary approach, particularly the integration of biomechanical measurements with motor control
theory, and will require the adoption of innovative techniques and methods that have only been fleetingly used in previous biomechanical investigations of sports techniques (e.g., Wheat & Glazier, 2006; Schöllhorn, Chow, Glazier, & Button, 2014). Interestingly, since the same principles governing coordination and control apply across all levels of analysis (see Glazier, 2010, 2015), techniques and methods from the related field of performance analysis could be used to gain a better understanding of how more successful players interact with teammates and/or opposition players, which may also be informative from a TID perspective.

References


