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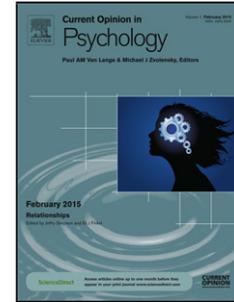
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## Searching for the Elusive Gift: Advances in Talent Identification in Sport

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### Highlights

- Exciting new multi-disciplinary studies offer unique insights to talent identification
- Emergent statistical approaches help to uncover the best predictors of future performance
- The widespread condemnation of genetic testing for talent identification in sport
- New approaches are emerging to counteract biases in talent identification
- Growing interest in talent identification in para sport

### Abstract

The incentives for sport organizations to identify talented athletes from a young age continue to grow, yet effective talent identification remains a challenging task. This opinion paper examines recent advances in talent identification, focusing in particular on the emergence of new approaches that may offer promise to identify talent (e.g., small-sided games, genetic testing, and advanced statistical analyses). We appraise new multi-disciplinary and large-scale population studies of talent identification, provide a consideration of the most recent psychological predictors of performance, examine the

emergence of new approaches that strive to diminish biases in talent identification, and look at the rise in interest in talent identification in Paralympic sport.

Increasing competitiveness in most professional sports incentivizes teams and organizations to identify talented athletes from a young age. Effective talent identification not only increases the likelihood of success, but can generate significant financial rewards (e.g., through the trade of players to other teams). Yet the early prediction of future performance remains highly challenging, and raises important ethical questions given the growing support for the diversification of early sport experiences and to avoid early specialization [1]. Here we address what we see to be emergent themes in talent identification, many of which highlight the complex and multi-dimensional manner in which talent develops.

#### *Multi-disciplinary and Large-scale Population Studies*

New work is addressing the enduring need for large-scale studies that employ multidisciplinary test batteries to prospectively test young athletes [2-7]. Notably, the German Football Association (DFB) in 2001 launched one of the largest talent identification and development programs on record, with 49 accredited youth academies performing standardized testing of the general physical ability and football-specific technical skill (e.g., dribbling, shooting) of young footballers [4]. The volume of data collected over 15 years has provided the opportunity to address pertinent questions related to talent identification, with studies emerging that evaluate: (a) the ability of different tests to discriminate between skill levels (most tests were good *except*, surprisingly, for a score of shooting ability) [2]; (b) the difficulties experienced by relatively younger players within age-groups, who need to overachieve to gain selection (whereas older children do not) [3]; and (c) the likelihood of talent-identified junior players becoming elite senior players [4]. In examining the age at which talented German footballers are identified, Gullich has shown that only a small proportion of first division footballers in Germany were in a youth academy from a young age (~20% by Under 11s). Instead, the proportion of youth academy players who achieve elite senior status tends to increase across each progressive age group. In this sense the talent pathway in German football allows a high turnover of players in and out of the pathway, with marked year-to-year turnover in both their youth academies (25%) and in the junior national squads (41%). This provides crucial opportunities for later developing

children to progress *into* the talent pathway, rather than limiting opportunities to only those identified from a young age.

New insights into what might be influencing *selections made by talent scouts* have emerged on the basis of cross-sectional multi-disciplinary studies of large groups from which scouts identify talent. Woods [8] compared the in-game physical and technical skill activities of drafted and non-drafted Australian football players, showing that those drafted were more likely to possess particular technical skill profiles (e.g., contested possessions and moves into an attacking zone; for other cross-sectional studies see [9-13]), providing some insight into what it might be that scouts are ‘identifying’. Similarly, O’Connor et al. [14] showed that from a common pool of youth players, those selected into a football academy were more likely to possess superior perceptual-cognitive skills than those not selected. Although the long-term accuracy of these selection decisions is unknown, these studies provide a model from which we can better understand the prevailing subjective judgements of talent scouts.

#### *In-match Evaluation of Performance for Talent Identification*

New approaches are being investigated to identify talent either during actual matches, or in scenarios that seek to represent match situations (e.g., small-sided games). For instance, Fenner, Iga and Unnithan [15] recruited a group of sixteen skilled U10 football players to play a series of four-versus-four small-sided games, but rotated players so that they combined with different team-mates each match. Results showed that the technical ability of each player (as subjectively evaluated by two coaches) could be very simply yet reliably predicted by tracking the overall success of the teams on which that player took part in (by counting the overall number of goals scored and matches won/drawn by that player’s teams). This finding suggests that technical ability, a highly desirable set of skills for the purposes of talent identification in football, can be identified simply by recording the performance of that player’s teams in small-sided games. In real matches, Goto et al. [16,17] used global positioning data to uncover measures that discriminated retained and released academy footballers, showing for instance that retained U9 players cover larger distances, particularly at low running velocities. Although these approaches may offer a means of evaluating the in-match skills necessary to succeed in complex sports such as football, their primary weakness is that they fail to disambiguate the *present*, and the *future potential* skill level (or ‘talent’) of an individual. For instance, a young athlete who has

extensive experience – yet limited potential in the sport – is likely to outperform another who is new to the sport, yet may have much more potential or ‘talent’.

### *Emerging Statistical Approaches*

There is growing acceptance of the need for more complex statistical analyses to better predict future performance on the basis of measures of talent. These approaches are needed to improve the specificity of the predictions made when using traditional techniques such as an ANOVA, MANOVA, or regression. A range of different statistical approaches have been introduced, including higher-dimension models that use *singular value decomposition* (similar to principal component analysis) to better group together related predictor variables [18]; *survival analysis* to understand the parameters that predict sport dropout [19]; and multivariate analyses typically relied on for the *evolutionary analysis of adaptation* [20], given the common interest in understanding the individual characteristics which lead to long-term success. Perhaps the most common new approach has been the use of neural network models (e.g., Kohonen feature maps, multilayer perceptrons) to better account for the potentially non-linear relationships between predictor variables and overall performance [e.g., 21,22,23]. Using these approaches, a model is created that does not necessarily assume future performance must be an additive effect of the predictor variables, but instead can act in a much more complex way. Generally, neural models are found to be better predictors of future performance (for an exception, see [21]). For instance, Pion et al. [22] found that a multilayer perceptron model was better able to predict sport dropout in young gymnasts than was either a linear discriminant analysis, or the subjective judgements of coaches. These newer approaches offer a promising way of better understanding the complex (and typically non-linear) interaction of different variables, and the roles they play in developing talent.

### *Psychological Predictors of Performance*

The search continues for factors related to *personality* and *cognitive function* that could influence the development of talent, and therefore may provide useful markers for talent identification. Recent work has focused on personality factors such as: (a) grit [24,25], hardiness and resilience [26-28]; (b) motivational characteristics such as achievement motivation, achievement goal orientation, and self-determination (e.g., [29]); (c) self-regulation [30,31]; and (d) higher-level cognitive functions such as working memory,

inhibitory control, cognitive flexibility, and metacognition [32]. The consensus appears to be so-far that psychological parameters play only a modest role in predicting actual performance [25,33,34], though they can be related to other aspects of success including commitment to and preparation for training, and psychological skill use [25].

Because of the modest contribution of psychological parameters to talent development (reflected by relatively small effect sizes), large-scale longitudinal studies are required to understand their true influence. Again, the work conducted by the German Football Association offers a useful insight. Höner and Feichtinger [34] examined the relationship between psychological characteristics and the future performance of 2677 U12 players taking part in the German football talent development program. Children were measured on up to 17 psychological scales designed to evaluate motivational characteristics, volition, self-referential cognitions, and emotion. The results revealed moderate relationships between a player's future success (four years later) and their performance on scales of *hope for success* (a sub-scale of motivation), *self-optimization* (a sub-scale of volition), and *specific physical self-concept* (a sub-scale of self-referential cognitions). Significant but weak predictive relationships (with low effect sizes) were also found for seven of the remaining 14 scales. Although the findings suggest a role for some psychological parameters in talent development, and provide guidelines for how those providing psychological support can assist talent development, Höner and Feichtinger suggest that the diagnostic value of those parameters is too weak for the purposes of talent identification, and therefore that their practical value is limited.

#### *Condemnation of Genetic Testing for Talent Identification*

An important trend has been the widespread condemnation of genetic testing as a means of talent identification in sport. The rapid development of genomic research has led to an expectation that genetic tests might provide a useful means of predicting future performance [e.g., 35]. For instance, there is evidence to suggest there is an over-representation of elite athletes in some sports with particular gene expressions (e.g., genes for the angiotensin I-converting enzyme and for  $\alpha$ -actinin-3; [36]). However, the value of these and other genetic profiles for the prediction of sport performance remains entirely unclear [37]. Unfortunately, this has not prevented the proliferation of new direct-to-consumer tests of genetic profile that claim to be able to identify athletic talent. Among

other things, the claims extend to the ability to provide tailored advice about a person's nutrition, injury risk, psychological aptitude, and potential in endurance and power-based sports [38]. Naturally, this knowledge is highly desirable for athletes, their parents, their coaches, and sporting organizations.

In light of the potential appeal of direct-to-consumer tests, a range of genetic researchers and clinicians have actively denounced the usefulness of genetic testing for the purposes of talent identification [38-40]. The absence of scientific support for the usefulness of this approach might not only provide a false assessment of a child's future ability, but their use is deemed unethical, and in some cases could constitute unlawful discrimination if used for talent identification [38]. Moreover, there remains concern about the quality control of direct-to-consumer testing, along with the absence of suitable genetic counselling from a medical practitioner or psychologist to appropriately interpret the findings. Instead, appropriately administered genetic testing may hold promise for better understanding and accounting for an athlete's susceptibility to injury [38,40].

### *Biases in Talent Identification*

Researchers continue to challenge the notion that talent selection in sport is done on a 'level playing field', with systemic biases existing in both talent selection and development. The 'relative age effect' remains a popular topic, with recent work focusing on understanding why this effect persists, and how it might be addressed. One proposed mechanism is that relatively older athletes are afforded superior practice opportunities than their relatively younger peers, including chances to practice with better players and/or more against teams of greater skill. Although seemingly straightforward, recent theoretical models explaining these effects [41-43] emphasize that the mechanisms underpinning them may be very subtle, perhaps explaining the difficulty in eradicating them from a sport system that seems well aware of their existence. For instance, Furley and Memmert [44] examined coaches' implicit beliefs about giftedness (i.e., talent), suggesting that coaches implicitly confuse physical size with athletic potential. Further, Hill and Sotiriadou [45] found that relative age effects remained even after coaches were made aware of the effect, suggesting education alone is not the answer (see also Helsen et al., [46]). Encouragingly, recent studies have suggested novel approaches to deal with these effects, such as the use of age-ordered shirt numbering [47], and corrective adjustments to performance times [48].

Perhaps most intriguingly, there is reasonably robust evidence supporting the notion that relatively younger athletes who are able to ‘survive’ in the biased system become more capable performers later in development (e.g., [49,50]). For example, McCarthy, Collins and Court [51] found that relatively younger rugby players were less likely to be selected to the national academy system, but more likely to transition into senior national squads. Collectively, these results suggest that the relative age effect is considerably more complex than previously assumed.

There has also been sustained interest in the ‘birthplace’ or ‘community size’ effect, which reflects the greater likelihood of high performance athletes coming from communities of a particular size (not too-large and not too-small). The hypothesis underpinning this effect is that regions of different size have qualitatively different developmental environments. First identified in 2006 ([52]; but see[53]), recent work in this area has focused on understanding the stability of this effect over time [54] and across different sporting systems (e.g., in Israel [55] and in Denmark [56]). Together, these results highlight the importance of considering cultural and sport-specific factors when determining the efficiency of decisions about talent selection.

#### *Unique Predictors of Talent in Para Sports*

Compared to able-bodied sport, research pertaining to talent identification in para sports (for athletes with impairment) is sparse [57,58], but there is some indication of change. While Spathis and colleagues [59] systematically examined sport-specific measures of talent identification, the remaining literature has considered the underlying issues underpinning a lack of effective measures. Talent identification in para sport has been limited by the smaller pools of athletes available for selection [60]. Radtke and Doll-Tepper [60] concluded that the lack of resources and funding at the grassroots level, along with limited communication between local and national organizations, has resulted in unsustainable talent identification and development systems. As a result, initiative programs (e.g., ‘Bridging the Gap’, ‘Soldier On’) that target novice athletes struggle to attract, maintain and develop athletes [58,60]. Even within systematic, goal-oriented programs (e.g., Long-Term Athlete Development in Canada), coaches and officials are concerned with the degree to which these programs can be put into practice, given that the majority of coaches at grassroots are volunteers [60]. The development of these programs is further complicated by the varying ages at which

athletes enter sport (e.g., debilitating injuries can be acquired at any age), which is extremely challenging for the development of age- or maturation-based criteria for talent selection. This sometimes leads to talent identification being performed on the basis of the severity of a person's impairment, with sport organizations attempting to identify athletes who barely meet the minimum impairment criteria for a given sport, so that they are less impaired than their opponents [61]. Taken together, limited resources at the grassroots level have impacted the systematic identification and development of the next generation of high performance athletes with impairment.

### **Concluding Thoughts**

Collectively, strong and continued interest remains in improving talent identification and selection in sport. Optimistically, the greater sophistication in research designs and statistical techniques, coupled with greater variation in athlete samples and continued focus on biases and limitations, suggests we may be getting closer to determining the ultimate value of 'talent' as a concept for those working in high performance sport.

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