IDENTIFYING AND DEVELOPING TALENT IN CYCLE SPORT

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Professional cycling is big business. It is widely reported that the 2015 budget for Team Sky was in the region of £24.4 million, with income from sponsorship providing the majority of the team income[1]. To ensure sponsor publicity and their sustained involvement in the team, there is a need for success. This is also the case at the Olympic Games and World Championships where riders compete for their countries. Sporting success is often seen as an indicator of national achievement and is therefore a high priority for countries around the world. In this regard, UK Sport's investment in British Cycling has risen from £8.6 million for the 2004 Olympic Games in Athens, to £22.1 million for Beijing 2008, £26.0m for London 2012 and £30.6m for the Rio Olympic cycle. As a consequence of this level of funding and pressure to succeed, teams and nations are desperate to identify and recruit the best athletes, with the process beginning at a young age[2]. However, effectively and efficiently identifying these talented individuals from the large pool of potentials available is both difficult and complicated. For example, the 2015 Union Cycliste International (UCI) report[3] estimates 2 billion bike users across the world, 500,000 of which are registered competitors, with 15,000 (3%) of these being professional riders across all cycling disciplines. Therefore, it is clear that some kind of selection needs to occur in order to identify and nurture the most promising talents, who have the greatest potential to achieve success on the international stage.

HOW ARE TALENTED ATHLETES IDENTIFIED?

While the ability of scouts or coaches to identify talented individuals should not be underestimated, it is very subjective[4] and the chances of identifying children who have the talent to become a successful senior athlete are remote. From an investor's perspective, investing funds in this form of talent ID would not be regarded as a wise use of money, as the chances of success are very small. As a consequence, there is considerable interest in the potential of establishing a 'scientific' selection process within elite sport, to identify individuals with a 'higher probability' of podium success[5].

Talent ID schemes are usually concerned with identifying morphological or physiological characteristics representative of elite athletes in the sport in question. The physiological demands of professional male road cycling are varied, with average powers of around 220 to 250 W (3.1 to 3.8 W/kg) being reported during flat stages[6,7] and 394 W (5.6 W/kg) being maintained for 30 minutes in mountain stages[7]. However, values as high as 383 W (6.0 W/kg) being maintained for more than 32 minutes have been reported in the literature[8]. During road sprints, peak values of 1248 W (17.4 W/kg) have been reported in the literature[9]. Even though short in duration (~13 seconds), these reported maximal efforts are produced following riding for many hours at ~200 W,

Table 1

	Males				Females
	Sprinter	Time trial	Climber	All terrain	
Age (y)	20 - 30	22 - 30	24 - 26	20 - 34	26 - 28
Height (cm)	173 - 179	176 - 188	175 - 180	180 - 189	167 - 171
Mass (kg)	64.0 - 72.8	70.0 - 75.0	60.0 - 66.0	68.0 - 79.3	60.0 - 62.0
Wmax (W)	395 - 461	521 - 560	404 - 480	410 - 450	312 - 354
Wmax (W/kg)	6.0 - 6.6	7.3 - 8.4	6.5 - 7.5	5.4 - 6.4	5.0 - 5.8
VO_2max (l/min)	4.5 - 5.2	4.8 - 5.7	4.9 - 5.1	5.2 - 5.6	3.6 - 3.9
VO_2max (ml/kg/min)	67.1 - 76.5	70.0 - 86.1	78.6 - 80.9	69.6 - 78.4	57.4 - 64.2

Table 1: Range of physical and maximal physiological characteristics reported in the literature for various professional rider groups. Wmax=maximal power output in watts. VO_2 max=maximal oxygen uptake. Data obtained from Mujika and Padilla[6], Menaspa et al[9], Ebert et al[10], Burke[11], Preiffer et al[12], Wilber et al[13], Santalla et al[14].

Table 2

	Males			
	Sprinter	Flat terrain	Climber	All terrain
Age (y)	16.9 ± 0.6	16.8 ± 0.7	16.7 ± 0.5	16.8 ± 0.7
Height (cm)	178 ± 4	181 ± 6	173 ± 5	176 ± 5
Mass (kg)	70.4 ± 4.7	70.4 ± 5.5	59.7 ± 4.4	64.5 ± 4.2
Wmax (W)	391 ± 35	398 ± 46	368 ± 4	408 ± 31
Wmax (W/kg)	5.5 ± 0.4	5.7 ± 0.5	6.2 ± 0.6	6.3 ± 0.4
VO_2max (L/min)	4.4 ± 0.4	4.4 ± 0.4	4.0 ± 0.5	4.5 ± 0.3
VO_2max (ml/kg/min)	61.9 ± 4.1	69.4 ± 3.6	67.5 ± 5.0	69.4 ± 43.6
MPO_5 (W)	1180 ± 95	1041 ± 141	857 ± 134	1079 ± 116
MPO_5 (W×kg)	16.6 ± 0.6	14.9 ± 1.7	14.4 ± 1.7	16.7 ± 1.1

Table 2: Range of physical and maximal physiological characteristics reported in the literature for elite junior rider groups. Wmax=maximal power output in watts. VO_2 max=maximal oxygen uptake. MPO_5=maximal 5 sec sprint power output in watts. Data adapted from Menaspa et al[20].

with the required power output increasing prior to the sprint as teams and riders jostle for the best position (10 minutes before sprint 316 W, 5 minutes 363 W, 1 minute 487 W)[9]. For females, the literature is considerably sparser, with only a few studies providing reference values[10-13]. One study[10] provides data obtained from 15 top-20 finishers of women's UCI World Cup road races. Average power outputs during flat stage races were found to be in the region of 192W (3.3 W/kg), 169W (3.0 W/kg) in hilly stages, with 12.4 and 5.3 minutes being spent at power outputs above 7.5 W/kg in flat and hilly stages, respectively. In conjunction with laboratory data from maximal incremental exercise tests, submaximal constant work rate tests and maximal sprint tests, it is possible to identify key anthropometric and performance characteristics of elite cyclists (Table 1). Despite a significant amount of data on the characteristics of professional male cyclists, there is minimal data on how anthropometric and physiological parameters differ between specialist road cycling disciplines (e.g. sprinter, climber, TT specialist, all terrain rider etc.). Nevertheless, clearly within elite endurance cycling, a high aerobic capacity (>75 ml/kg/min), an ability to exercise at a high proportion (>70%) of that for a prolonged period of time, a high level of efficiency (~22 to 24%) and a good anaerobic power production ability (~15 to 17 W/kg) are important for success in elite cycling, regardless of specialty[14-17]. However, the rider's adaptability to training and the variability of physiological protocols used in their assessment, make the utility of these parameters problematic in talent ID systems. Anthropometric and physiological parameters may be useful for talent development and training purposes as they track performance changes well. Since many of these anthropometric and physiological factors are also affected by the processes of maturation[18,19], caution should be applied in solely using these variables for talent ID purposes. It is therefore problematic to try to use data collected from junior athletes to predict their senior performance, without somehow accounting for biological maturation. There is a paucity of data on elite junior road riders in the research literature, with only one study[20] presenting a comprehensive analysis of anthropometric and physiological characteristics (Table 2). However, caution should be applied to the interpretation of the data for talent ID, as it is unknown whether any of the riders presented in the study went on to successfully compete in the elite senior ranks.

Even if a cyclist has the physical attributes associated with success in a particular discipline, their potential to succeed also depends on other factors such as commitment, motivation and determination[21-23]. Indeed, there is good evidence that at the elite level (whether junior or senior), that successful athletes display higher levels of confidence, motivation, mental toughness and resilience in high-pressure situations than less successful athletes[21,22,24]. Moreover, there are key motivational characteristics and personality traits displayed by successful athletes at all levels of performance[25]. It is clear that a unitary approach to talent ID is warranted, in which psychological factors and personality profiling are combined with anthropometric and physiological profiling to assist in identifying athletes with the potential to develop into future champions[26]. However, questions remain outstanding in relation to the key personality and psychological aspects of performance and how those displayed as a junior influence and shape future success as a senior.

So what is the evidence? The East German regime of the 1960s and 70s stands out as a leading proponent of talent ID. However, it has since emerged that much of their success

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was built on a legacy of doping and other extreme practices that represent the more unsavoury side of elite sport. Nevertheless, certain elements of the old East German system were incorporated into Australian programmes of the 1990s, specifically the need to identify the right athlete for the right sport. Following a dismal display in the 1976 Montreal Olympic Games, the Australian Government decided to overhaul their system of identifying and developing talented athletes. They subsequently formed the Australian Institute of Sport (AIS), which was tasked with identifying and offering scholarships to talented athletes across a range of Olympic sports. In anticipation of the 2000 Games in Sydney, the AIS tested every child in Australian schools for their athletic potential and compiled a bank of fitness and basic body measurements to identify a 'best fit' sport for each individual. A number of former German Democratic Republic coaches and scientists (e.g. Heiko Salzwedel for cycling) were drafted in by Australia to assist in the development and implementation of a national talent search programme. This nationwide programme pinpointed a handful of talented athletes in each focus sport, with the Government then investing millions of dollars into supporting these individuals at both local and national levels. This approach was undoubtedly successful as it boosted Australia's medal haul from five in Montreal to 60 in Sydney. Cyclists such as Robbie McEwen and Cadel Evans being notable products of the programme.

Some other nations have attempted similar talent ID approaches, albeit on a smaller scale and with more a focused remit. For example, prior to the London 2012 games, a partnership between UK Sport and the English Institute of Sport introduced the 'Tall and Talented' programme aimed at identifying athletes aged 15 to 22 years who were over 180 cm (female) or 190 cm (male) and had the potential to become rowing and basketball Olympians. Following a series of assessment events, athlete test data from anthropometric, strength, endurance, power and agility tests were benchmarked against data collected from previously successful Olympians. This data was added to expert coach opinion in order to identify those with the most potential to develop and thrive in a world class sporting environment. More recently, British Cycling has launched a similar talent ID campaign titled Discover Your Power, which aims to target powerful 15 to 21-year-old males and females who might be the next generation of Olympic and Paralympic track cyclists. Specifically, the scheme aims to identify individuals who have raw speed or power, which may enable them to be fast-tracked into their high-performance programme. In professional cycling, several teams have developed talent ID systems. One example is a partnership between Team Giant-Alpecin and the German Cycling Federation (BDR). The partnership runs German talent days in an attempt to identify young riders (17 to 20 years) who demonstrate the potential to become elite riders of the future. The talent days provide the opportunity for riders to gain coaching and guidance from the professional team and the BDR. However as discussed later in this article, it is important that talent ID and development starts at an early age and is sustained over a prolonged period of time. As a progression route for talented riders and staff to bridge the gap between national and world class performance levels, many of the World Tour teams (e.g. Cannondale, AG2R, Europcar) also run successful development teams.

Talent ID schemes are not solely the domain of national governing bodies or governments. In 2002, the UCI opened the World Cycling Centre (WCC) in Aigle, Switzerland, with a broad range of aims related to the promotion of cycle sport across the world. As part of its work, the WCC and its four satellite centres (New Delhi, India; Potchefstroom, South Africa; Taejang-li, South Korea; Shuzenji, Japan), aim to provide opportunities for talented riders from continents and nations with traditionally lower resources or facilities to compete against the more established cycling nations. Specifically, the UCI's

aspiration is to create and develop a high-performance structure that operates at all levels, from talent ID through to the coaching of both junior and elite riders. Riders identified by local coaches are invited to attend a training camp at one of the WCCs where they undertake a series of physiological tests and are benchmarked against standardised criteria. These tests involve a total of four 'all-out' efforts, 2 x 6 seconds with 234 seconds recovery in between, 1 x 30 seconds with 330 seconds recovery and 1 x 4 minutes. While at the training camp, riders are also assessed for their attitude towards training and competition and are taught certain life skills necessary for a career in elite cycling (e.g. basic nutrition and meal preparation). Particularly promising riders are then selected to continue training at the WCC in Aigle. Several WCC riders have been successful in making the transition to professional cycling teams, including the Eritrean Daniel Teklehaimanot, who became the first African to wear the King of the Mountains jersey at the 2015 Tour de France.

Despite such schemes and national trends, there is minimal evidence that these talent ID strategies have consistently contributed to the sporting success of top sporting nations[2]. There is also limited research on what constitutes sporting excellence and how this might vary across different disciplines within cycle sport, as well as between sports. Moreover, it could be argued that talent ID is very reductionist in its approach and fails to appreciate that sporting excellence is not solely related to a specific set of physiological attributes, but rather determined by a unique combination of attributes, attitudes and behaviours[28]. In this regard, talent ID approaches (at both immature and mature stages of development), often fail to capture the multiple interactive and compensatory processes that take place within and between innate capabilities, psychological behaviours and the environmental conditions[2].

IS TALENT INNATE?

There is debate within the literature as to the relative importance of nature versus nurture in the careers of elite athletes. Research has started to identify specific genetic profiles of non-elite athletes, claiming to be able to account for up to 66% of the variance in sporting performance[29]. However, even though genetic factors might influence which sport non-elite individuals are most likely to successfully compete in, elite performance is not necessarily well predicted from genetic factors[30]. Nevertheless, elite athletes competing at the pinnacle of their sport are likely to possess a rare combination of gene variants that predispose them to obtaining the required phenotype for world-class performance[31].

Not only may genetic inheritance influence success in cycling, but also the time of year a particular rider was born. The 'relative age effect' refers to a disproportionate over-representation of elite athletes born at the beginning of any given competitive year, versus an

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underrepresentation of those born at the end. Indeed, in the youth ranks of elite cycling where the calendar year dictates age categorisation, there is high likelihood of selection bias as riders are often chosen due to physical, behavioural or psychological maturity, which then becomes self-reinforcing over the years. Indeed, data collected data from 5928 riders[32] between 1980 and 2014 found that riders with birth dates of January to May represent a greater proportion of pro-peloton than riders with birth dates in months June to December. Cycling is not alone in displaying a relative age effect, a recent review by Cobley et al[33] suggests it also exists in sports such as basketball, baseball, ice hockey, soccer and volleyball. However, this evidence is not conclusive and there are plenty of examples in elite cycling where the relative age effect does not stand up; Alberto Contador, Vincenzo Nibali and Tom Boonen all have birthdates later than May in the calendar year. Therefore, more research is needed to fully understand the extent to which the relative age effect impacts on initial involvement in cycling or the extent of early career success.

IT'S NOT SOLELY GENETICS

Some individuals display skills and aptitudes at a young age and become elite junior riders without the apparent need to undertake many years of training. Indeed, success within the junior ranks is often used as a method for selection to a performance development programme[34]. However, it is not certain that these riders go on to a career at the elite level or vice versa, an individual who lacks the innate precursors for performance will never excel. Indeed, retrospective and prospective data from Schumacher et al[35] demonstrate that in a sample of 4432 athletes over a 22-year period, 29.4% of elite cyclists had participated in the junior World Championships and that 34% of the participants in junior World Championships later participated in major elite cycling competitions. Thus, a young rider's talent potential is not a stable innate trait, but something that is constantly transforming during the maturation process. Schumacher's data also suggests that a high proportion of riders are lost at a junior level or are missed due to lack of opportunities and thus never make the transition from junior to senior rankings. It is unclear why this might be the case, although the process of maturation is likely to reduce the predictive ability of talent ID tests and performance at a junior level. It could be speculated that as riders move from junior to senior ranks and physiological attributes of elite cyclists become more homogenous, psychological aspects become the key determining factor for sporting success. If this suggestion holds true, it is intuitive to presume that the model of cycling performance is likely to be different between junior and senior riders and might provide another explanation as to why some fail to make the transition. Alternatively, a rider who fails to demonstrate the required skills and aptitudes at a young age should not be completely disregarded; it might be that they develop the required skills and aptitudes during their junior years, only reaching the elite level within the senior ranks.

Junior development squads and programmes are not the sole route to the development of talent seen at elite level. It has been shown that at the elite level, talent in one sport may be metamorphosed into another talent in another sport[36]. For example, in talent transfer schemes, established elite athletes with specific skills and body types are matched to another sporting discipline. Rebecca Romero first won Olympic silver as a rower in the quadruple sculls at the Athens Games of 2004, took up cycling in 2006 and then went on to win two gold medals for Great Britain at the 2008 Beijing Olympics. This type of evidence suggests that athletes on such programmes can reach the same level of performance as their elite peers within 1 to 2 years of the transfer of sport[37]. However, notwithstanding this specific example, support for the widespread use of 'mature age talent identification' and 'talent recycling' is scarce. Moreover, both of these processes are beset by the same limitations as traditional talent ID models; namely, they attempt to identify talent using anthropometric, physiological and performance 'snapshots'. There is also no strong evidence to support the notion that an athlete's success can be attributed to the skills they acquired in their previous sport[37].

TALENT ID MUST BE SUPPORTED BY A SCIENTIFIC DEVELOPMENT PROGRAMME

Environmental factors are thought to play a key role in the progression of junior athletes into the elite ranks[38]. The use of a scientifically-informed talent ID system will only be successful if it is incorporated into an effective talent development programme in which athletes are provided with the optimum environment for nurturing their abilities. The talent development programme provides the opportunity for the best resources to be targeted at those individuals with the greatest potential of becoming elite athletes.

Many factors are involved in – and influence the process of – talent development, including; access to an effective coach who can provide expert tuition to develop both physiological and psychological skills[25], access to the right facilities, parental pressures and the support network[39]. However, research investigating the influence of some of these factors in shaping an athlete's development and progress towards the elite ranks is sparse. What is clear from the literature is the need to consider the development of an athlete over a prolonged period of time, termed long-term athlete development (LTAD)[40]. Athlete development must be prioritised over the focus on early career success, where coach and team selection is based on just a few individuals[2]. As outlined by the aforementioned work by Schumacher et al[35], only ~30% of elite senior riders at the World Championships had been elite juniors. For this reason, a focus on early successes, elitist coaching and talent selection may not be the most effective way of producing elite senior riders. Instead it is clear that talent emerges with the right experience, that is developed over time[38]. Indeed, starting the development process at a young age will assist in ensuring the individual undertakes the amount of deliberate practice that is required on the pathway to elitism[41].

Various models have been suggested that characterise such LTAD. In cycling a late specialisation model has been proposed in which a general approach to early training is emphasised, prior to specialisation occurring during the teenage years[40], using a staged approach:

1. FUNdamental stage
2. Learning to train
3. Training to train
4. Training to compete
5. Training to win
6. Retirement/retraining

A number of national sports federations have implemented various versions of the LTAD model. In cycle sport, examples include USA Cycling, Cycling Canada and Cycling Australia. An example of a long-term developmental pathway in cycling is provided by the British Cycling Rider Route programme. This performance pathway aims to assist the progression of riders towards the elite ranks. Go-Ride, the foundation of British Cycling's development programme offers a safe and fun way to introduce young riders to cycle sport and a platform to improve bike handling skills. Talented riders aged 12 to 15 are invited to attend one of a number of the regional schools of racing across the UK, where they are provided with training and guidance from a British Cycling coach. From here, approximately 100 are invited to become apprentices in a national programme. Shortlisted riders are invited to become part of the British Cycling Junior (15 to 17 years) or Senior (17 to 21 years) Academy, before finally progressing on to the Podium Programme. At the pinnacle of their talent development programmes, British Cycling currently supports 49 'Podium Athletes' aiming to medal at the next Olympics and a further 61 'Podium Potential Athletes' whose performances suggest that they have realistic medal winning capabilities at the subsequent Olympic Games. However, while the LTAD model has been widely used and advanced coaches' understanding of the importance of physiological variables, biological maturation and implementation of training in young athletes, the limitations of this approach also need to be acknowledged. Firstly, the LTAD model is currently not well supported by empirical evidence[42]. Moreover, there is a danger that if the LTAD model is followed in a literal sense, some athletes may be written off at an early stage if they do not meet certain criteria based on average scientific benchmarks[42]. Finally, as outlined above, talent ID and development cannot be seen as a single formula for success; instead it should be viewed as a complex multi-factorial system that is highly dependent on the individual athlete in question. It is clear that more work needs to be undertaken to refine the LTAD model in regard to developmental issues in children and adolescents and in terms of how physical athletic performance can be improved at the various stages of an athlete's career.

CONCLUSIONS

High-performance cycling appears to depend on a multitude of factors such as genetics, training, the environment in which the athlete is positioned, encouragement and social support and the effect that these have on the individual athlete's physical and psychological capabilities. However, the mechanisms of these interactions are not clear and further research is required to optimise the talent ID process. What is clear is that without the optimal environment in which the rider has the opportunity to learn and develop, they will never reach the pinnacle of the sport. Therefore, following identification, talented riders must be supported by an effective talent development programme which nurtures and supports them in the correct environment to assist them in achieving their full potential. However, unfortunately to date there are no long-term prospective studies that aid the understanding of how elite performance is affected by interventions at a junior level.

References

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