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Science and the Making of the Athletic Body

Introduction

At the 1960 Rome Olympics Britain's Don Thompson won gold in the 50 kilometres walk. Nicknamed *Il Topolino* (The Little Mouse) by the Italian press, Thompson's victory was proclaimed heroic and 'plucky' in a quintessentially British way. His preparation had been unconventional to say the least. Thompson, who was an insurance clerk, had collapsed in the heat at the Melbourne Games in 1956 and in order to prepare himself for the humidity of Rome he created a steam-room effect in his bathroom using kettles and heaters, and walking up and down continuously on the bathmat.¹ His feat though was set against the growing rivalry in international sport between America and the USSR where greater resources in terms of coaching and sports science were being dedicated to the preparation of their athletes for the Olympic arena. By contrast, Thompson's preparation reflected British sport's amateur tradition.

This chapter charts the evolution of athletes' training methods since the early nineteenth century. At the root of this process has been an on-going tension in the relationship between coaching and science. The relationship between sport and science rather than a story of unhindered scientific progress has been a process shaped by its prevailing social and cultural contexts. Roy Porter has pointed out, because of a two-way cultural traffic in knowledge, much of modern scientific medicine owes its foundations to traditions that have been described as folk, popular or rural in origin.² Tensions between coaching and science, therefore, need to be placed in the context of not only scientific developments but also changes in the sporting world. In addition, the development of training methods reflects the recurring issue over the definition of sports medicine itself; in other words, where does medicine stop and science begin? Track and field athletics is used as the main case study because it has been this sport more than others where the relationship between sport and medical science has been not only the closest but also has had the most dramatic effect on athletic performance.

Early trainers and coaches

Ideas on what constituted the athletic (or sporting) body had begun to take shape in the late eighteenth century. The gambling on sports such as prize-fighting and pedestrianism generated not only a competitive impulse but also a greater demand to improve the performance of athletes through more systematic training regimes. To begin with, instead of scientists, it was the coaches and trainers³ of prize-fighters, pedestrians and rowers from the late eighteenth and early nineteenth century who were first practitioners of bodily instruction. Coaching itself is a process of 'knowledge transfer' but one subject to its own cultural and social context. Coaches and trainers have acted as 'gatekeepers' by exercising a large influence over their sports both socially and in sporting terms. Through their attitudes to coaching, which have been moulded by their own experiences, coaches have transmitted values as well as knowledge to athletes, and shaped the way that sports have been played. Although many early coaches/trainers were poorly educated they were also autodidacts and to a certain extent scientists in their own right. Their training theories were empirically-based deriving from observation, experience and an oral tradition where they learnt by 'stealing with the eyes'. Coaches formed their own communities of practice where information was only passed on within tight social networks and was not chronicled for fear of rival coaches gaining an advantage.⁴

Two of the earliest books on athletics training included John Sinclair's *Results of the Enquiries Regarding Athletic Exercises* (1807) and Walter Thom's *Pedestrianism*, published in 1813. From his investigations Sinclair concluded that there was little difference in the training of horses, fighting cocks, pugilists, greyhounds and runners.⁵ Galenic humoural theory (see Chapter 1) formed the basis for the training regimes of early modern athletes. Medical treatment, therefore, was through either changing the lifestyle of the patient or by restoring the humoural balance.⁶ Trainers had two main aims. The first was to achieve this balance in the body by removing impediments through a programme of diet and exercise. Thus, at the start of training athletes first would have their body cleansed of gross humours through the standard means of purging, vomiting and bleeding.⁷ This cleansing could involve the taking of three purgatives, such as Glauber's salt, over a four-day period as well as any other emetics thought appropriate.⁸ The second main aim was to improve the wind, i.e., stamina, of athletes through exercise, which mainly consisted of walking or running. Any additional sweating, purging or even bleeding was undertaken when deemed necessary.⁹

The most famous pedestrian of the early 19th century was Captain Robert Barclay who, for a substantial bet, walked 1000 miles in 1000 hours on Newmarket Heath in the summer of 1809. A Yorkshire farmer, Jackey Smith, who it was claimed was 'very knowing in all sporting science', supervised his

daily regime, which lasted for three to four weeks.¹⁰ Smith controlled Barclay's sleep patterns and woke him up at 4am to move him from his bed to a hammock as it was felt that this would loosen his muscles ready for training. His day began with the taking of emetics to purge the body of toxins. Running started at 6am with Barclay wearing layers of clothes including two pairs of breeches, which were designed to make him sweat. A massage followed and then a rest in a heated bed. His sweat would be replaced by a tankard of strong malt liquor followed by an hour of relaxed walking in warm dry clothing. In the afternoon there was more running, including sprinting uphill. He ate a high-protein diet that consisted of undercooked beef, mutton and raw eggs. During the challenge itself Barclay was assisted by a medical attendant, William Cross, who was responsible for treating injuries and perhaps more importantly ensured he didn't fall asleep before or during the walk.¹¹ Barclay himself turned trainer and used similar methods in preparing the pugilist Tom Cribb for his fight against the former American slave, Tom Molineaux, in 1811. Tom McNab has argued that Barclay's methods lingered on well into the twentieth century in many sports.¹²

Early 'scientific' training 1870–1914

During the final quarter of the nineteenth century there was a growing reaction against the training methods of Barclay. From around 1870 onwards the term 'scientific training' was gradually used to refer to the training of athletes. However, this was a reference to regular and systematic preparation rather than biomedical science. Instead 'most training methods continued to rely heavily upon the accumulated experience of successful athletes and trainers'.¹³ These changing attitudes to the training of athletes had been buttressed by the emergence of scientific (or Western) medicine during the nineteenth century.¹⁴

Since the Renaissance period rational theories of the body began to challenge and replace Galenic-based ideas. With the discovery by William Harvey (1578–1657) of the circulation of blood, hydraulic models of the body emerged. In the seventeenth century Rene Descartes (1596–1650) argued that the human body was a machine operating according to mechanical laws and principles while the soul operated autonomously. Previously, Galenic ideas of the body had viewed the attainment of health holistically. Now Cartesian dualism saw the body as being no longer determined by 'virtues' of mysterious *vires* but instead by technical concepts such as motion, size and temperature. The professionalization of science during the nineteenth century created an institutional framework for the spread of scientific ideas. Western medicine established a reductionist approach in which the examination of bodies and their diseases were localized and analysed into ever-smaller parts. This reductionist approach led to the employment of machine models of the body

that integrated anatomy, mechanics, physiology and psychology into the study of human sporting performance.¹⁵ The invention of medical instruments, such as the microscope, enabled physiological researchers to analyse changes in the pressure and flow of body fluids, to measure changes in body temperature, isolate and stimulate tissues and glands. This allowed investigation of bodily functions and to explore the chemical and nervous pathways by which the body's functions co-ordinated.¹⁶ Through further developments in physiology, such as the work of Claude Bernard on metabolism, the body was seen as a self-regulating mechanism that needed to be kept in good running order by exercise and diet.¹⁷ From a scientific point of view it became more acceptable for athletes to work their bodies harder and to push themselves to the limit. Sport and especially track and field athletics provided ideal material for scientists interested in bodily functions and movements.¹⁸ However, as with most theories, there was a lag before new ideas were put into practice.

Scientists were originally more interested in studying athletes for the purposes of physiology generally rather than consciously attempting to boost their performance. As Cronin points out, up to 1914 the worlds of sport and medicine saw little value in engaging with the other. A few scientists were interested in athletes but only as subjects for medical research.¹⁹ Phillipe Tissié, for example, was interested in the physiological impact on the body of a French cyclist in his (failed) attempt to break the record for the 24-hour distance event in 1893.²⁰ In 1906 a Dutchman, Van den Berg, also examined the effect of cycling on the heart.²¹ Other pioneers included Etienne-Jules Marey (1830–1904) who through contemporary photographic technology developed an interest in the biomechanics of sport.²²

Scientific experiments were generally of an *ad hoc* nature. There was no critical mass of scientific knowledge and medical debates continued over the amount of stress that physical activity could place on the body. Tissié, for example, reflecting contemporary attitudes, actually opposed competitive sports due to their apparent 'medical dangers'. Of particular concern among scientists was the condition commonly referred to as 'Athlete's Heart'. Because of its vital function, debate continued over the consequences of competitive sport on the heart throughout the twentieth century.²³ 'Athlete's Heart' first became associated with sport following the 1867 university boat race between Oxford and Cambridge. Writing in *The Times*, the physician, F.C. Skey, denounced the competitive nature of such contests and their consequences for the body.²⁴ By the 1980s, however, the Athlete's Heart had become 'normalized'. While the enlarged Victorian Athlete's Heart was regarded as pathological and unhealthy, it was now seen as fit and physiologically adaptable.²⁵

Of perhaps more long-term importance to the relationship between athletics and science was the development of anthropometry. During the Victorian era there was an increasing obsession with measuring body parts and body types, and in particular to identify the 'normal body'. This 'normalcy' through the

application of anthropometric techniques aimed to determine the 'athletic body' through physiognomic schemes.²⁶ These ideas had their roots in early nineteenth-century theories about heredity and breeding, which were used in horse racing and cock fighting. However, with the emergence of eugenics and racial theories they were now given a greater scientific platform. A leading proponent in America was Dudley Sargent, Harvard University's director of PE. He had instituted a programme of exercises, known as the 'Sargent System', based on a dynamometer and lung capacity tests.²⁷

The growing literature on physical culture produced by the likes of Sandow and Müller provided ideas for bodily instruction through weight-training and exercise programmes plus advice on diet and lifestyle as well as providing visual representations of ideal body types.²⁸ In 1901 another prominent physical culturalist, Eustace Miles, in conjunction with F.A. Schmidt, wrote *The Training of the Body*, which was more of a coaching manual. It analysed mechanical movements of athletes in activities as diverse as bowling and climbing. Miles was also a champion rackets player and had added information derived from his own experiences.²⁹ The muscular ideal mainly promoted by Sandow still remained central to physical culture but others as well as doctors advocated a less muscular physique, and this advice spilled over into sport. The male body was now of neo-classical proportions, which balanced height, weight, muscle development and mobility. The ideal athlete, therefore, was neither too tall nor too small, too thin nor too fat.³⁰ At the same time, and seemingly running in contradiction to the growing scientific evidence, there was a growing emphasis on moderation regarding training and competition. But this reflected 'an evolving amateur attitude amongst doctors which saw "staleness" as the physical manifestation' of an unhealthy obsession with sport and placing too great an importance on winning.³¹ These doctors adopted the aphorism, 'Athletics for health is safe. Athletics for prowess and superiority may be dangerous.'³² Staleness amongst athletes, its causes and the quest to cure it, would continued to be a topic of debate deep into the twentieth century.

In light of the emergence of scientific medicine and new ideas regarding the body, unsurprisingly, there was much criticism of old-style trainers. In particular their use of purgatives and other home-made concoctions, which were originally thought to prevent the 'staleness' of athletes through over-training.³³ Archibald Maclaren's *Training in Theory and Practice* (1866) made this particular point. As well as physical education, Maclaren also had a background in medicine.³⁴ For him, rather than excessive exercise, and ultimately injury, it was purging, vomiting, the denial of liquids and eating semi-raw meat that led to athletes 'training off'. Maclaren further argued against the use of heavy clothing to reduce weight through perspiration. Basing his argument on physiological knowledge, he argued that this would not affect fatty tissue as changes in the tissues were dependent upon changes in respiration and circulation.³⁵ Maclaren

was also interested in different body shapes, reflecting the Victorian fascination with the ideal of the symmetrically appropriate body.³⁶

The Lupton brothers made a strong case for athletics to develop links with the medical profession and also criticized the traditional methods of trainers.

These antiquated ideas are not fossilized yet: men exist who prescribe raw meat as food and withhold drink from parched lips; who reduce the body 'to get off substance' far below its natural weight. By these means weakness not strength is induced; the man so trained cannot win.³⁷

While acknowledging the skills of professional coaches and trainers, the Lupton brothers also bemoaned the lack of orthodox medical input. They admitted that the surgeon lacked the practical knowledge of training that professional coaches possessed but it was hoped that 'if the science of the one could be blended with the practical experience of the other in one individual, we should then be able to give the world assurance of a trainer'. In addition, 'Medical students might with advantage educate themselves to this end, and in a very short time the athletic world would possess men capable of giving practical and scientific advice and training quarters'.³⁸ However, there was little cross-over between professional coaches and trainers who continued to rely on traditional methods and the growing number of doctors who had played sport at public school and university and were imbued with different sporting values. Professional coaches and trainers continued to rely on their own 'eye' and tacit judgement. Their knowledge base was wide and included an eclectic range of sources such as medical science, physical educators, animal trainers, circus performers, newspapers, sporting journals and magazines. Because they heavily favoured empiricism to experimental science, coaches felt that, rather than anthropometric techniques, each individual had their own complex psychological make-up and that this was just as important in assessing the potential of athletes.³⁹

Some athletes also had their own individual training programmes with little input from coaches. Walter George, who set a world record for the mile in 1886 that lasted for nearly 30 years, was famous for his 'hundred up exercise' where he would chalk a line on the floor in the pharmacy where he worked and prance on the spot, lifting his knees high.⁴⁰ Later, George's training was based on running every morning and afternoon where he mixed up his regime. He alternated slow runs of one to two miles with faster stretches of 400 to 1,200 yards with a series of short sprints.⁴¹ While George had turned professional to race, Arnold Stode-Jackson, winner of the 1,500 metres at the 1912 Olympics, embodied the British amateur ethos. Educated at a public school and then Oxford, his approach to training was casual, consisting mainly of massage, golf and walking. However, he had an abundance of natural talent.⁴²

Successful British coaches by the early twentieth century included Sam Mussabini and Harry Andrews whose methods were largely based on their

own observations. Andrews was renowned for training professional runners like Alf Shrubb who at one time held every world record from 2 to 10 miles. Like many trainers he promoted the virtues of walking. For training for the longer distances, he advocated that runners wore plenty of clothing to lose fat.⁴³ Mussabini coached Olympic champions like Reggie Walker (South Africa), Harold Abrahams, both in the 100 metres, and Albert Hill, who won the 800 metres and 1,500 metres in 1920. Another Mussabini athlete, Willie Applegarth, won a gold in the 4×100 metres relay in 1912. In addition to the preparation of athletes, Mussabini was very interested in the biomechanics of running and used slow motion film and photographic sequences to study athletes in action. He was also interested in the stride length of sprinters especially their arm swing and various phases of the sprint race, and he recognized through trial and error that sprinters decelerated during the race.⁴⁴ Both also believed that athletes needed a good constitution with a strong stomach and sound digestive organs. For constipation, for example, Mussabini recommended one of his home-made laxatives called 'Black Jack'.⁴⁵ Both Andrews and Mussabini were also strong advocates of the use of massage for runners as well as an adherence to hygiene.⁴⁶ However, they were also alive to modern developments. Andrews, for example, was not averse to administering drugs like strychnine to his athletes, albeit in exceptional circumstances.⁴⁷

International sport and the rise of coaching

Although Britain had been the pioneer, from the late nineteenth century modern sport began to take on an international dimension. Football was being exported to Europe and South America while cricket and rugby were played in the British Empire. America, through professional baseball and inter-collegiate sporting competition, was establishing its own particular sporting culture as was Australia. In addition, there was growing competition between Britain and America in sports such as athletics, swimming, rowing and cycling. Moreover, the inauguration of the Modern Olympics in 1896 provided a platform for national pride and from 1908 they were increasingly fuelled by nationalism. As a consequence, national sporting performance became an important indicator of a nation's health. With this growth in competition, there was a greater demand for athletes to have the best possible preparation for the Games.

International sport began to unravel British amateur attitudes towards coaching. Fears over the perceived consequences of any sporting decline can be traced back to at least the 1906 Intercalated games in Athens where blame was pointed at the lack of organization for British athletes. This had contrasted sharply with the more systematic approach of the Americans and Scandinavian

countries.⁴⁸ After the 1908 Olympics, where the American team had won thirteen out of the twenty-three track and field events, it was commented that the British were amateurs and had to be more 'business-like' like the Americans who were regarded as professionals.⁴⁹

Following a disappointing performance in Stockholm in 1912, further questions were raised about Britain's lack of coaching expertise and preparation in comparison to other nations. The hosts, for example, had appointed Ernie Hjertberg as its chief athletics trainer. A Swede by birth, he had lived in America for forty years coaching in universities and private athletic clubs. For the Stockholm games he had organized the training and selection procedure for Swedish athletes in 1911.⁵⁰ The British response was to put a national scheme of coaching in place, highlighting a shift away from 'pure' amateurism towards a greater emphasis on the pursuit of excellence. In addition, a Canadian, William Knox was appointed as national athletics coach. He was well known on the (professional) Highland Games circuit and specialized in field events. The preparations for the 1916 Berlin Olympics were linked to anxieties over Britain's sporting prestige, racial hygiene, social Darwinism and Britain's place in the world order.⁵¹ Germany itself had been given an incentive to improve its sporting performance when Berlin was awarded the Games. In addition, up to 1914, Germany had been the leader in experimental physiology, partly because of the amount of testing taking place on its soldiers. In Britain there was a fear that their scientific discoveries would be applied to German athletes.⁵²

It was in America though where the greatest developments in coaching were being made. Here coaching had flourished under the collegiate system through the likes of Walter Camp, Clyde Littlefield and Brutus Hamilton.⁵³ Inter-varsity competition provided a structured and highly competitive sporting environment that fostered a large pool of athletic talent and created a demand for coaches. Importantly, these educational institutions became sites for experiments and the advancement of coaching knowledge and practices. American coaches adopted a more specialized and systematic approach to coaching that reflected more generally the growing influence in America of F.W. Taylor's ideas on 'scientific management'.

Walter Camp, recognized as the 'father of American football', also explained American football in terms of rational efficiency. Influential in writing (and re-writing) the laws of the game between 1878 and 1925, he was also the (unofficial) coach of Yale for twenty-five years and the 'leading foot-ball expert in the country'. For Camp, American football was a game of tactics and leadership and this notion was passed on to other sports like baseball and basketball. As a result, in American sports the emphasis on the coach orchestrating games from the sidelines has offered a striking comparison to sport in other countries.⁵⁴ The importance placed on the coach in American sport was in direct contrast to attitudes to coaching in Britain.

On Roger Bannister's lack of a coach, J. Kenneth Doherty commented that (half tongue-in-cheek):

To an American this is heresy. No coach to make decisions, to seek aid for financial problems ... No coach ... to influence the faculty in shifting exam schedules, to suggest that the girl friend might well stay until after the big race is over ... No coach to scare away the heebie-jeebies of doubt and fear by quoting medical authorities that "physical activity", no matter how strenuous, cannot harm a healthy heart or other vital organs of the body.⁵⁵

By contrast, the strong strain of anti-coaching in Britain was summed up by Ronald Kittermaster, headmaster of King's School in Worcester. He believed that:

The training of athletic champions for national or international sport is entirely foreign to the British educational-athletic tradition ... The view that the object of all sport should be competition ... is an un-British and anti-educational view, a denial of all that is best in sport.⁵⁶

While there is more than a little amateur myth-making to this statement, it does give an indication about the different attitudes towards coaching in different countries, and hence the relationship between sport and science.

Before 1914 the pre-eminent American athletics coach was Michael Murphy who was credited with the invention of the crouch start for sprinters. Selected to coach the American Olympic teams in 1908 and 1912, he had previously worked at a number of clubs and was also coach at the University of Pennsylvania. Although Murphy had undergone some medical training and was a friend of R. Tait McKenzie, his methods were based on his own observations rather than any experimental studies. His attitudes to physical conditioning, for example, placed an emphasis on cleanliness, deep-breathing, at least eight hours sleep, bathing, massage and simple calisthenics. In addition, he stressed that athletes should not over-train.⁵⁷ Dean Cromwell (1879–1962) was another eminent American coach. He coached ten Olympic champions, including Charley Paddock in the 100 metres in 1920. Although he was dismissive about the myth over the athlete's heart, his training motto was about 'moderation' as he did not want his charges to overextend themselves in training.⁵⁸

Science and sport in the inter-war period

During the inter-war period a greater rational-scientific approach to sport emerged. A 'paradigm shift' took place in the scientific understanding of the training of athletes and a scientific body of knowledge was built concerning human physiology through recorded observations related to exercise, human anatomy and physiology.⁵⁹ Cronin has identified the period from the 1920s as one when medicine begins to use sportsmen as guinea pigs to determine what a healthy body was and to develop theories of athletes as distinct and

special.⁶⁰ Nevertheless, there was still a considerable lag between the discovery of this new science and its application in elite sport. While the twenties and thirties were important decades in the development of sports medicine through a greater physiological understanding of athletes' bodies, practice was and continues to be ahead of theory. Arnd Kruger has argued that even as late as 1979 'the practice of training was still ahead of theory'.⁶¹

The two leading nations regarding this relationship between science and the training of athletes were America and Germany who established the foundations for the discipline of exercise physiology.⁶² Following the 1924 Olympics, scientific studies were published by a number of American scientists that used athletes as subjects. These included the successful eights crew at the 1920 and 1924 Olympics where Yale University physiologists set out to measure 'the maximum that the human engine can attain in any form of exertion'. Tests included measurements of rowers' mechanical efficiency whilst on the water and oxygen consumption through the 'Douglas Bag' while the crew rowed on an indoor rowing machine. From their results they claimed that a man could use fat as the exclusive fuel for intense exertion.⁶³ As we have seen in Chapter 3, the 1928 Olympics provided the first opportunity for doctors and physiologists to undertake anthropometrical and cardiological tests on competitors – mainly runners and sprinters.

A significant event in the history of sports science was the establishment of Harvard University's Fatigue Laboratory in 1927. Research on fatigue had at first been directed towards the fitness of workers through the use of ergogenic aids but was given further impetus following a demand for greater knowledge on soldiers and battle fatigue after the First World War; its impact on athletic performance was incidental.⁶⁴ Founded on the principles of F.W. Taylor's scientific management and Frank Gilbreth's time and motion studies, the laboratory became one of the main sites for research into human performance based on physiological responses to activities involving endurance, strength, altitude, heat and cold.

One of the most influential scientists on human performance was the British physiologist Archibald Vivian Hill. With the German biochemist, Otto Meyerhof, Hill had been awarded the 1922 Nobel Prize for Physiology and Medicine for discovering the distinction between aerobic and anaerobic metabolism.⁶⁵ In 1925 Hill's scientific achievements had been given world-wide recognition with his Presidential address to the section on physiology of the British Association for the Advancement of Science, 'The Physiological Basis of Athletic Records'. In 1927 he published both *Muscular Movement in Man* and *Living Machinery*. Hill had been a keen runner in his earlier years and this had given him an interest in the study of the physiology of athletes for the benefit of the wider population.⁶⁶ In 1923 he explained that:

Athletics, physical training, flying, working, submarines or coal-mines, all require a knowledge of the physiology of man, as does also the study of conditions in factories. The observation of sick men in hospital is not the best training for the

study of normal man at work. It is necessary to build up a sound body of trained scientific opinion versed in the study of normal man, for such trained opinion is likely to prove of the greatest service, not merely to medicine, but in our ordinary social and industrial life.⁶⁷

Hill believed that athletes were easy subjects to experiment on as they could repeat exactly their performances. At Cornell University in 1927 he measured the acceleration of sprinters – who were wearing a magnetic band – through the use of a galvanometer. Large coils had been set up at 1 to 10-yard intervals alongside a track and each time a runner passed by a coil a deflection was recorded with the velocity computed by dividing the distance between each coil by the elapsed time. But another motivation for him was that the study of athletes was ‘amusing’. It again highlighted the novelty of the relationship between sport and medicine, and his digression into applied exercise physiology was said to be puzzling to his peers.⁶⁸

Between 1922 and 1924 Hill’s research had focussed on the relationship between muscular exercise, lactic acid and the supply and utilization of O_2 – oxygen deficit and debt – when athletes had been running. In stressing the importance of ‘maximal O_2 uptake’ ($VO_{2\max}$) Hill was able to show how it determined athletic performance; the longer athletes were able to sustain their $VO_{2\max}$ for extended periods, the better their performance. In order to obtain high levels of $VO_{2\max}$ and at the same time prevent the build up of lactic acid within their muscles, athletes required a systematic training regime, or as it was termed, ‘the steady state of exercise’.⁶⁹ Hill’s research not only formed the basis for sports science and exercise physiology but his work also provided a medical basis for coaching texts that were able to take into account the physiological limits and potential of athletes’ bodies.

The core of Hill’s theory – that the athletic body’s capacity for stress was greater than it was first believed – was put to the test by athletes and coaches in Northern Europe. Finland’s Paavo Nurmi was amongst the first to recognize that athletes could increase their training workload. He was famed for his even-paced front-running that was built on a three-times a day training regime.⁷⁰ Uniquely, Nurmi won the 1500m and 5000m at the 1924 Olympics on the same afternoon. His training was built on the principle of running different distances including repeated sprints. The pioneer in this area of training was the Finnish coach, Lauri Pikhala. What he called ‘Terrace Training’ stressed a balance between work and rest.⁷¹ Yet Nurmi only trained in the spring and summer as winter training was not considered necessary.

Nurmi’s principle of alternating work with recovery periods was built upon by the German, Dr Woldemar Gerschler. He was the head of the Freiburg Institute of Physical Education and also the coach of Rudolf Harbig. Using Harbig as a guinea pig, Gerschler was an early promoter of interval training – resistance through repeated speed. This training system basically aimed to alternate hard, measured runs with recovery runs over a set time. It could

then be tweaked through manipulating distances, repetitions and the recovery interval. Using this regime Harbig set world records for both the 400 metres and 800 metres in 1939.⁷² Gerschler worked in a three-man team. The other two were a cardiologist, Herbert Reindell who provided Gerschler with scientific research on the effectiveness of interval training, and a psychologist called Schildge.⁷³ One part of Harbig's training included a workout of ten repetitions of 400m. Through measurements of his heart rate after a run, they were able to calculate the optimum rest period before Harbig should run again. As Nicholas Bourne has argued, the close monitoring of heart rate and division of time within time to form intervals represented 'a significant increase in the level of sophistication and objectivity of the training process'. The use of 'measured work intervals' now allowed athletes to increase their training intensity above race pace. This translated into better performances on the track. In 1930 the Swedish coach, Gosta Holmer, invented an early form of interval training, the fartlek system. It was a form of endurance training that systematically alternated different running speeds – sprinting, striding and easy running – over varied terrain. Its most famous exponent was the Swedish middle-distance runner, Gunder Hagg. During the Second World War he broke fifteen track records. His world record for the mile, 4:01.4, lasted from 1945 until 1954. Interval training still forms the bedrock of training programmes for many athletes.⁷⁴

Coaching and the British amateur hegemony

During this period British athletics was dominated by an amateur elite, in particular, the Achilles Club. It was formed in 1920 and comprised a network of Oxbridge old boys. Successful members of this club at Olympic level included Douglas Lowe and Lord Burghley. However, while amateurism remained the dominant sporting ideology, there was a growing awareness of Britain slipping further down the international sporting pecking order. One member, Harold Abrahams, famously employed Sam Mussabini as his coach in preparation for the 1924 Olympics, signalling a shift from the ethic of pure amateurism. In addition, there was an evolution in athletics training literature, which was dominated through the publications of Achilles members.⁷⁵ Some were based on the latest scientific research, such as that of A.V. Hill, and criticized past methods, reflecting wider debates between orthodox and unorthodox medicine. In *Training for Athletes* (1928) Adolphe and Harold Abrahams stated that, 'Quacks and charlatans ... know that the best appeal is the introduction of something mysterious cloaked in pseudo-scientific phraseology'.⁷⁶ By contrast, they advocated a study of an athlete's tissues to understand muscular activity.⁷⁷ Although it tried to debunk some myths, *Training for Athletes* was not a complete break from past practices and ideas on the preparation of athletes.

While it advised against the use of alcohol as a tonic for athletes, alcohol was also seen as a medicine and as a way of averting occasional bouts of staleness.⁷⁸

New developments also blended with a traditional British aversion to professionalism and specialization. Sport was still regarded as a force for good in terms of participation, which was preferable to the pursuit of winning. In 1929 Douglas Lowe and Arthur Porritt declared that:

We want our athletic “giants” just as we want our great “brains” but we want them as incentives and as examples, not simply as perfected mechanisms through which to advertise. We feel sure that those who have the cause of athletics most deeply at heart will endorse the opinion that if athletics are to retain their very definite ideals they must be thrown open more and more to the average man – to all men! And surely enough in the process, the great athletes will still be found, without the selfish hot-house production by today’s specialisation methods.⁷⁹

Lawrence and Mayer have identified the inter-war years as a period when scientists and medical doctors were in a contest with their rivals and peers in the arts and other professions, and perceived part of ‘their moral duty to publicize their social and moral insights’.⁸⁰ Porritt saw athletics as a power for good for mankind, and advocated a ‘sensible’ training programme and to ‘Mix’ with your fellow athletes, remembering that if there is a greater gift than health it is friendship.⁸¹

In addition, despite the appreciation of the new science and in contrast to the training regimes of athletes such as Nurmi, moderation was still a key theme in British literature.⁸² To develop stamina, for example, Douglas Lowe, winner of the 800 metres at the 1928 Olympics, stressed ‘never do too much in training’.⁸³ In *Athletics* Lowe and Porritt state that, ‘The essence of ... training should be embodied in the word moderation’.⁸⁴ Much emphasis was also placed on the importance of style over training for endurance and stamina.⁸⁵ On the matter of training school boys Webster and Heys advised against an arduous schedule and believed that a coach who sets a boy ‘to run a fast mile on five days out of seven is nothing less than a criminal lunatic’.⁸⁶ Instead, the advice was ‘Little and often’.⁸⁷ The Cambridge-educated Irishman Robert Tisdall advised that ‘Style comes first’.⁸⁸

The leading British thinker on coaching in the inter-war years was F.A.M. (Frederick Annesley Michael) Webster. Almost uniquely among British coaches, he brought a rational and scientific approach to the field events, which because of the British harrier tradition had been the bridesmaid to those on the track. He also was familiar with A.V. Hill’s work on oxygen debt as well as drawing on the work of Pavlov to theorize about the effects of anxiety on the efficiency of an athlete’s circulation and digestion. In 1934 he was appointed the first director of the AAA summer school at Loughborough. However, Webster was a relatively lone voice and there was a lack of a coaching culture in Britain. Following the success of German athletes at the Berlin Olympics and the fear of an impending war, the British government did place a greater

emphasis on coaching through the formation of the National Fitness Council. The AAA saw this as an opportunity to revive the idea of a national coaching scheme and a head coach. Interestingly, the candidate the AAA chose was an Austrian, Franz Stampfl, indicating the lack of suitable British candidates.⁸⁹

The athletic mind

Similar to attitudes towards training the body for competition, coaches were also aware of the importance of the preparation of an athlete's mind. While the methods of modern sports psychologists may reflect a more scientific approach, those employed by traditional coaches shared a desire for a similar outcome for their athletes. The notion of the 'will', therefore, has been a recurrent theme in sporting discourse and is reflected in its current use through words such as determination and commitment. In the nineteenth century the 'will' was largely expressed in terms of 'character', 'courage' and 'pluck'. In Britain these qualities were to take on a distinctly British edge. Playing sport itself, for example, had been thought to be character building, especially within public schools. In his book on boxing A.J. Newton claimed that 'Courage, British bulldog hanging-on pluck wins many a fight against superior odds'. Importantly, 'there must be no element of funk'.⁹⁰ There was also an awareness of funk (panic or cowardice) in athletics and how nerves played a part before a big race. Harry Andrews suggested that a coach should talk to the athlete about anything but the race itself to keep his mind occupied.⁹¹

For those belonging to the amateur elite the motivation of athletes remained a personal matter. Lowe and Porritt were generally dismissive of the views of trainers and instead it was advised that athletes should develop their own powers of rational judgement and weed out what was useful and what was not. As a consequence, the mental side of training involved 'the cultivation of self-discipline and will power', i.e., 'pluck'.⁹²

Sports psychology as a medical sub-discipline was pioneered in America by Norman Triplett. In 1898 Triplett, a cycling enthusiast, observed that social influence, through a pacing machine and competition, seemed to motivate cyclists to better performance.⁹³ Coleman R. Griffith became the first person to conduct systematic sport psychology research and practice. Between 1925 and 1932 he was the director of the Athletic Research Laboratory at the University of Illinois as well as working in professional sport. On one occasion he interviewed Red Grange following a Michigan-Illinois college football match who told Griffiths he could not remember a single detail of his performance; highlighting how some top athletes play on instinct alone. Griffiths also corresponded with Knute Rockne on the psychology of coaching and motivation. In 1938 the Chicago Cubs hired him as a team sports psychologist.⁹⁴ Sports psychology in Germany was also being developed, first by August Bier and then Robert Schulte. Initially, it reflected a form of constitutional psychology, which was

largely based on racial anthropology where performances it was thought were due to an athlete's fixed temperament.⁹⁵

While there was an awareness of the 'mental side' of sport, the psychological methods used in British sport were mainly non-scientific and could be described as cod psychology. During the 1930s a number of football clubs experimented with 'psychological methods'. Some clubs, including Arsenal, Brentford and Sheffield Wednesday, used the Reverend M. Caldwell, a chaplain to two large London 'mental' hospitals who was described as an expert in practical psychology and gave lectures on what he termed 'psychotactics'. At one time, Wolves players also attended regular sessions at a local psychologist in an attempt to build up their confidence.⁹⁶ The *ad hoc* nature of these experiments reflected not only a growing acceptance of Freud's ideas from the turn of the century but also a popularization of psychology. As a consequence of a lack of authority within psychiatry, it had allowed a host of people to practice and disseminate their own brand of psychology through classes, magazines and books.⁹⁷

The Football Association's first coaching handbook also placed an emphasis on the need for the coach to apply a psychological approach and identified 'types' of players. One was the 'timid' type another the 'strong, eager, thrustful type', plus the player who 'gives up' easily was seen as another problem. While it was felt necessary to instil self-confidence in timid players, 'thrustful' players required 'firm but tactful handling'. Those who give up were deemed to lack 'backbone' and at times 'a really sharp word' was necessary.⁹⁸ In general, psychological techniques in football were relatively rudimentary and for many years managers based their ideas largely on traditional masculine values. It was in the 1990s, following the large injection of television money and the arrival of foreign coaches, that saw the introduction of sports psychologists into British football.

Sports science in the post war period

Following the Second World War elite international sport was transformed. Due to the onset of the Cold War there was an intensification of sporting competition. Although it never escalated into a full-scale military conflict, 'it did become a "hot war" in the context of sport, where superiority was not an abstraction, but a reality to be demonstrated repeatedly and conspicuously'.⁹⁹ It was particularly the Olympic arena where rivalries between East and West were played out. These developments further stimulated ideas about enhancing performance that were increasingly based on a physiological paradigm.

The major characteristic of the training schedules of athletes, especially middle- and long-distance runners was the increase in the volume of their workload. No-one epitomized this more than Emil Zátopek. Whereas in Britain

emphasis was placed on the importance of style, Zátopek was known for his ungainly gait. After winning the 10,000 metres at the London Games, he then, uniquely, won the 5,000 metres, 10,000 metres and marathon at the 1952 Olympics. He aimed to dominate races from the front and this entailed training every day.¹⁰⁰ He did so without a coach or stopwatch but his schedule was so gruelling that the coach Fred Wilt described him as the 'originator of modern intensive training'.¹⁰¹ It was claimed that Zátopek trained for five hours a day, seven days a week, and his daily workout consisted of twenty repetitions at 200 metres; forty runs of 400 metres before finishing with twenty repetitions at 200 metres. Each interval was followed by 200 metres of jogging and the time taken for the intervals after a 400 metres was 75–90 seconds.¹⁰² Zátopek was the example that others such as Peter Snell and Jim Ryan followed in pushing back the barriers of human endurance and the stresses on the human body.

Of course, there was always the possibility that athletes could over-train. The British marathon runner Jim Peters was one who had increased his training workload to Zátopek-like levels. In 1951 he had stated that he trained five or six times a week, and on a Sunday he pushed his son's pram on a three hour walk. In 1949–50 his annual training mileage had been 1,400 (2,253 km) from 190 runs but by 1952–53, this had increased to over 4,000 miles (6,400 km) from 500 training runs. In 1953 Peters set a world best for the marathon of 2 hours 18 minutes 40.2 seconds. However, based on Peters' insatiable appetite for training, Harold Abrahams declared that 'Jim Peters' Plans Frighten Me'. He offered no scientific evidence for this and recognized that standards had improved but he believed that Peters was pushing himself too far.¹⁰³ Abrahams' words were prophetic. At the 1954 Empire Games Peters was leading the marathon when he entered the stadium. However, under a hot sun he was a ghostly figure who staggered towards the finish and fell over six times. He never reached the tape and eventually became unconscious. He was put on a saline drip as his life hung in the balance. Peters never ran again.¹⁰⁴

One of the most acclaimed sporting achievements in the early post-war period was Roger Bannister breaking the four-minute barrier for the mile in 1954. In the process Bannister beat his main rivals, America's Wes Santee and John Landy from Australia, to the mark. In some quarters it was declared amateurism's final hurrah. The main protagonists, Bannister, Chris Chataway and Chris Brasher, were represented as sporting gentlemen and a throwback to an age of amateurism that was now under threat from a sporting nationalism stoked by the Cold War; a popular perception that still persists.¹⁰⁵ However, much of this rhetoric concealed the reality of a well-planned and well-executed race that had been underpinned by modern training techniques. In the first instance Chataway and Brasher were pacemakers and pacemaking was illegal at the time under AAA rules. Moreover, they had all received tuition from the Austrian coach, Franz Stampfl (although he was not their full-time coach).¹⁰⁶ Bannister himself was a medical student on the cusp of an outstanding

career and was able to apply scientific principles to his training. Although his observations on his training were regarded as largely subjective, Arnd Kruger has concluded that his training theory was ahead of its time.¹⁰⁷ He was familiar with the literature in experimental physiology and ran experiments on himself to enhance his performance, which included treadmill runs with oxygen-enriched air. He also used the Swedish fartlek and interval training techniques as well as the most advanced technology available.¹⁰⁸

Athletes of all disciplines also began to adopt weight-training programmes after 1945. These naturally included the throwing events but even runners like Zátopek used weights to strengthen themselves.¹⁰⁹ As we have seen, an early promoter of weight-training was Eugen Sandow. Thomas Delorme later developed resistance weight-training programmes for the rehabilitation of World War Two veterans. These had helped restore muscle strength and speeded up their recovery. Furthermore, Peter Karpovich helped to debunk the muscle-bound myth of weight-training and outlined how a systematic programme could increase speed, reduce injury and improve flexibility.¹¹⁰

The growing acceptance of the benefits from a more scientific perspective led to the emergence of sports medicine and sports science as academic disciplines in the post-war period. These developments were now driven by the idea of excess rather than moderation.¹¹¹ Beamish and Ritchie have argued that in the 1960s the modern principles of athletic training became 'scientifically entrenched'. This created a further paradigm shift that led to 'the application of physiological principles to understand and enhance performance in athletics'.¹¹² Mignon has added that 'Sports medicine of the 1960s saw the emergence of a new type of individual, "the trained athlete", different psychologically and physiologically from the man in the street'.¹¹³

A number of physiological studies – of how cells and organ systems of the body perform their functions – had had an important impact on coaches and their approach to training athletes. First, Thomas Cureton in his study of physical fitness that had been conducted at the University of Illinois's Physical Fitness Research Laboratory linked body build with athletic performance.¹¹⁴ More significant to the understanding of training and improvements in performance was the work of Hans Selye (*The Stress of Life*, 1956) on the body's adaptation to stress. Selye's work allowed coaches and athletes to better understand the limits of an athlete's performance especially in light of the increased training workloads they now were undertaking. Selye advanced the theory of the General Adaptation Syndrome in which stress was regarded as 'the wear and tear caused by life' with life itself seen as 'a process of adaptation to the circumstances in which we live'. It was found that through internal organs such as the endocrine gland and the nervous system the body adapted to stress. At first the body would be in shock to any form of stimuli but there would then be a process of counter-shock, which enabled it to adapt and resist until it reached a stage of exhaustion.¹¹⁵ Thus, for athletes it was necessary to build up their reserves of resistance.

In the early 1960s biomechanics also emerged as a sub-discipline within exercise and sport science, partly due to the technical advances in film, which allowed coaches to now view the movements of athletes in slow motion. One of the pioneers was Geoff Dyson, chief national coach of the AAA from 1947 to 1961. His *The Mechanics of Athletics*, based partly on Newton's laws of motion, was regarded as the most authoritative text on the subject.¹¹⁶ While Tom McNab has described Dyson's rational, scientific approach to coaching as transforming the post-war British athletics literature, it also brought a devaluation of practical experience. As a consequence, there was a biomechanical bias to the coaching literature.¹¹⁷ A conversation between Dyson and Cureton highlighted these on-going tensions between the practical and the scientific. Whereas Cureton had insisted a particular high jumper could have jumped higher if he had been fitter, Dyson argued that this was simplistic and a more intuitive approach was required that took into account age and the technical abilities and deficiencies of the jumper.¹¹⁸

Despite British sport's prevailing amateur ethic the 1968 Mexico City Olympics signified a closer relationship with science. In 1965 the British Olympic Association organized a party of doctors, scientists and athletes to investigate the effects of altitude on athletic performance in readiness for the 1968 Games, which were held at over 2000 metres above sea level. While thinner air was expected to assist sprinters and athletes in the field events, it was thought to be detrimental to those in endurance races. Interestingly, these were not only expressed in terms of the health of athletes but also that the choice of Mexico City was unfair and contrary to amateurism and the Olympic spirit. The British Olympic Association (BOA) subsequently concluded that a minimum of four weeks training at altitude was needed. The International Olympic Committee (IOC) had previously set a maximum period of four weeks in a pre-Olympic training camp but it signified that even amateur athletes now required regimented and scientific training.¹¹⁹

Coaching in Australia

Coaches in Australia were also beginning to adopt nascent sports science techniques after 1945. Largely unaffected by the war, the early post-war period was a golden period for Australian sport, particularly in tennis, swimming and athletics. Coaches though provided the cutting edge. These included Harry Hopman in tennis, June Ferguson in athletics and swimming's Forbes Carlile.¹²⁰ In particular, Australian coaches – in all sports – collectively rejected the idea that heavy training created staleness in athletes. Instead, there was a growing belief that they should be trained to the point of exhaustion.¹²¹ While different coaches utilized science in different ways, an application of scientific principles was at the heart of these developments.

Chief among these were Australian swimming coaches, especially Forbes Carlile. Carlile was an early advocate of Selye's General Adaptation Syndrome

and had also been a pupil of Professor Frank Cotton, regarded as the 'father of sports science in Australia' who had developed a connection with the Harvard Fatigue Laboratory during the 1930s. Carlile, a lecturer in physiology at the University of Sydney, provided a bridge between 'hard' science and coaching in Australian sport. Carlile had gained a master's degree on 'Studies in the physiology of muscular exercise', which included evaluations of body measurements, the effects of heavy training and changes in athletes' blood profiles. As a consequence, in his book *Forbes Carlile on Swimming*, he firmly sets out what this meant for swimmers: 'Let us get this straight from the start – preparation for top competitive swimming must be a well-planned, year-round process'.¹²² While acknowledging that every athlete was different and that many coaches could tacitly recognize the signs of exhaustion and over-training, he argued that 'the challenge for the physiologist was to be able to measure the amount of general and specific adaptations to stress and to find reliable tests of how long an individual was able to resist a given stress'. He identified a number of the stresses of the swimmer in training, like muscular exercise and bacterial infections, and a list of symptoms of failing adaptation, such as chronic loss of body weight and psychological unrest.¹²³ While Carlile had been a professional swimming coach since 1955, ironically, he did not receive universal (and Australian) recognition for his methods until 1962 after his success with the Dutch national team at the European championships.¹²⁴

The two most significant coaching figures in Australian athletics during this period held ideological differences in the training of athletes. Whereas Franz Stampfl advocated a rational and scientific approach, his great rival Percy Cerutty favoured one based on naturalism. As we have seen, Stampfl first coached in Britain and was associated with Roger Bannister. However, he eventually settled in Australia where he trained the likes of the multiple world record holder Ron Clarke and the 1968 Olympic champion at 800 metres, Ralph Doubell. While he did not adopt scientific principles to the same extent as Carlile, Stampfl's approach was a combination of Newtonian principles of motion and Hans Selye's theories of stress adaptation. His preferred training method though was interval training. He also argued that athletes suffered from too little training and that, staleness, the bogey of athletes and coaches could be avoided by a gradual build up in the volume and intensity of training.¹²⁵

In addition to John Landy Percy, Cerutty also coached Herb Elliott, arguably the greatest miler in history. His philosophy of training shared similarities to the counter-culture and a rejection of Western materialism as well as with early twentieth century physical culture. He largely rejected new scientific fashions and derided Stampfl's methods as boring and regimented. Cerutty developed his training ideas from experimentation on himself and applied many of the principles derived from studying the movement patterns of race horses and big cats. He was also in debt to the physical culturalist George Hackenschmidt as a teacher of living, both physical and mental. Cerutty developed his own

philosophy called ‘Stotanism’ – a derivative of Stoic and Spartan based on his reading of medieval writings on religious asceticism – which placed great emphasis on combining the natural environment with the training of athletes. He set up a seaside training camp in Portsea in Victoria where his athletes famously trained on its steep sand dunes as well as golf courses and forests. There were also a variety of activities that mixed running, including fartlek, on different surfaces with weight-training and swimming and were set to music from Calypso to Beethoven. At the centre of his methods was a belief that life’s realization could be developed through running.¹²⁶

Boxing and sports science

The adoption of sports science throughout the sporting world was never universal and in fact was very uneven. Its reception was dependent on the financial means and will of individual countries, which partly reflected the importance they placed on sport as well as the extent of cultural resistance within individual sports. In boxing, for example, training methods could be termed traditional, which reflected the working-class backgrounds of both trainers and fighters. Few had access to medical journals and trainers worked within their own communities of practice in which methods were passed on by word of mouth. However, even boxing’s citadel was beginning to be breached by the 1980s. The film *Rocky IV* offers a contrast between traditional and modern training techniques (and also an allegory for the Cold War). In their preparation for their fight, Rocky Balboa adopts traditional and natural methods that utilizes nature, the American Great Outdoors, whereas his Soviet opponent’s training is given a sinister spin as it is undertaken in laboratory-like conditions using modern sports science techniques, including illegal drugs. Of course, Rocky wins but in reality sports science was now been advocated for boxing in America.

However, scientific methods were not widespread. In 2002 it was stated that ‘the use of so-called “old-school” training methods such as long distance running and the avoidance of weight-training still persist in boxing today’.¹²⁷ More boxers, however, have employed strength and conditioning experts who have begun to replace the all-round role of the trainer. Whereas previously the trainer dealt with every facet of the boxer’s regimen, the roles of cornermen have become more specialized. One of the first American boxers to adopt sports science techniques was Evander Holyfield. In 1986 he teamed up with a strength and conditioning specialist, Tim Hallmark. Essentially, Hallmark transformed Holyfield’s preparation. Out went the traditional miles of roadwork and hours of sparring. In its place came a comprehensive weight-training programme, sprints and plyometrics – exercises that incorporate jumps and hops to enhance speed and strength. Conditioning drills would be followed with the monitoring of Holyfield’s heart rate to assess workrate and recovery as well as analysis of his blood, urine and saliva to give hormonal and metabolic feedback on his state of health and response to training.¹²⁸

Sports science in Eastern Europe

Following the Second World War Eastern Europe, led by the Soviet Union, largely rejected its former ideological commitment to non-competitive physical, cultural activities and embraced the previously tainted 'bourgeois' sports. In particular the Olympics were seen as an arena to display the virtues of communism as a superior way of life compared to the decadent West. This use of sport as a political tool by the Eastern bloc was highly successful in terms of the results achieved. When communist countries first made their debut at the 1952 summer Olympics they won 29 per cent of the medals; in 1976, it was 57 per cent. The USSR 'won' every Olympics, summer and winter (bar 1968 and the winters of 1980 and 1984) while between 1956 and 1976, the German Democratic Republic (GDR) advanced from 15th to 2nd in the medal table.

There has been a popular (mis-)conception that this success was solely achieved through a systematic drugs programme (see Chapter 5). While drugs were certainly a factor, this view fails to take into account that the structural foundations of sports medicine were deeply embedded within the state machinery of Eastern bloc countries. Interestingly in Eastern Europe, like the West, there was disagreement over what constituted sports medicine. While the USSR (see Chapter 1) primarily saw it as part of a wider health agenda, reflecting a pre-war tradition of physical culture, in the GDR, reflecting a wider German tradition, the priority was sporting performance and hence there was a greater emphasis on sports medicine as science.¹²⁹ By the 1960s the focus of GDR sports medicine was on discovering talent, planning individual training regimes and treating sports injuries. In the Soviet Union, from a total of 3 million full-time athletes, each one was attached to one of 400 sports medical dispensaries, which employed 5,500 doctors; 14 for every dispensary.¹³⁰

The communist sports system contrasted with attitudes in the West where coaches still regarded their practices as an art rather than a science, and continued to work alone utilising knowledge within their own 'communities of practice'. The success of athletics and sport in general amongst Eastern bloc countries was due to a greater scientific approach, and in particular, the idea of periodization. Periodization prepared athletes for competition using a highly sophisticated system involving training cycles and a variation in the volume and intensity of workouts, which was designed to bring athletes to a peak for a particular event, such as the Olympic Games. Of course, this was the aim for the vast majority of coaches. However, periodization was the product of an all-encompassing theory of sport and training, which was the work of the Soviet training theorist, Lev Pavlovich Matveyev, published in 1965. Through periodization an athlete's training programme was divided into specific cycles of time and was another by-product of Soviet planning science. Matveyev incorporated aspects of Selye's work on stress and adaptation but this was to be part of an overall coaching system that allowed athletes to peak for competition.

It was only in 1975 that periodization entered the lexicography of Western coaches through Britain's Frank Dick's critique of Matveyev's theory.¹³¹

In Eastern Europe a totally different approach to training also emerged as coaches worked together with scientific researchers. Instead of looking solely at physiological responses to exercise, a more holistic view was taken.¹³² Nicholas Bourne has argued that in 1969 the Soviet coach V. Popov was the first to advocate the comprehensive planning of training, and that this was 'a watershed moment that demonstrates how the planning of training and theory began to be recognized as an independent discipline in its own right'.¹³³ His plan featured a division of labour where training was broken up into specific yearly, monthly and weekly cycles.¹³⁴

The state-sponsored athletic body

In response to the sporting success of Eastern European nations, the governments of Western countries also began to develop a fixation for sporting success on the international stage. As a consequence, the state began to intervene in the development process for elite sports. To gain state aid, national governing bodies now had to adopt professional management structures as well as high-quality coaching and talent identification schemes.¹³⁵ It was argued that for nations to 'optimise their chances of winning medals' at Olympic Games on a consistent basis they need to 'develop, operate and provide funding for an efficient Elite Athlete Development (EAD) system'.¹³⁶ In 1976 Australia failed to win an Olympic gold medal. It produced much navel gazing and in response – which was a cultural response, highlighting the national importance that country places on sport – in 1981 the Australian Institute of Sport was founded. It marked the start of the nationalization of elite (Olympic) sport in Australia.

In Britain this process did not start until the 1990s when it was bolstered by funds from the National Lottery, which began in 1994. However, since then the increased state investment in elite sport has required that each national governing body has a talent identification and development strategy, something that was set out in the 2002 government report, *Game Plan*.¹³⁷ As a consequence of this political outcome, British elite sport, in addition to EAD systems, has become aligned to sports science through the adoption of a generic model for developing athletic potential, Long Term Athlete Development (LTAD). LTAD systems are predicated on notions that it takes 8 to 12 years of training or 10,000 hours for a talented athlete to reach elite levels.¹³⁸ The LTAD model has outlined a comprehensive and structured training programme, competition and a recovery regime to ensure optimum career development, and has been developed by Istvan Blayi, a sports development expert, on the basis of research into physiology, physical development and the analysis of training/competition outcomes. Under this

system, sports are classified as either early specialization, which require early sport-specific specialization in training or late specialization sports, which require a more generalized approach to early training.¹³⁹ The LTAD is essentially a rationalized, scientific and mechanistic paradigm that now drives performance sport. There is also an insistence that coaches fully integrate sports science and sports medicine into their programmes. In particular, a great deal of emphasis is placed on physiology with successive stages of the model described as 'building the engine', 'optimising the engine', and 'maximising the engine'.¹⁴⁰ At the centre of the LTAD's methodology is a belief that anthropometric measurements and physiological evaluations enable the accurate assessment of an individual's suitability for an event and allow potential athletes to be counselled towards appropriate sports.¹⁴¹

However, to what extent is the LTAD a new departure or does it reflect on-going tensions over the rational scientific model and the intuitive skills of the coach? Perhaps surprisingly Steve Cram, given his status as chairman of the English Institute of Sport, but maybe less so considering his experience as an athlete, has reservations over this approach. He has argued that the emphasis on the 'hot-housing' – i.e., scientific evaluation – of athletes devalues individual motivation as the main attribute of a top-class athlete.¹⁴² There is also a sense that the LTAD is an unwieldy, one-size fits all model, which has been used for the benefit of government because of its quantitative, easy to measure function that suits large bureaucracies. In one study on football, despite the failure to find any significant variables the authors still concluded that anthropometric measurement should remain an integral part of a performance profiling programme.¹⁴³ Instead, Dave Day has argued that research findings should remain part of the toolbox of coaches, which should be used intuitively, instead of being imposed on coaching.¹⁴⁴

Conclusion

By the twenty-first century, one of Britain's most successful athletes was a woman, Paula Radcliffe. World record holder in the marathon, it has been estimated that in 2003–04, she earned over £2 million per year. But these commercial rewards have only been achieved through a mixture of natural ability allied to a strenuous regime that has reflected the greater scientific attention that athletes give to their training. Through a mixture of trial and error and advice from coaches, sport scientists and sport medics, Radcliffe trains on an eight-day cycle, which includes two long runs, a hard session every other day and a rest day. Every morning she checks her pulse and if it is over a certain mark (45 beats per minute) it signifies she has not fully recovered from the last hard session and hence she regulates her training accordingly. Her weekly distance is around 145 miles, which equates to over 6,000 miles per year, a figure exceeding that of Jim Peters in the 1950s, when Harold Abrahams

declared that his plans scared him. Radcliffe has regularly trained at altitude in the Pyrenees and in the American Rockies, a route that many modern athletes have taken since 1968. Training at altitude increases red blood cells in an athlete's body, which in turn maximizes his/her oxygen carrying capacity. She also maintains this 'oxygen debt' by sleeping in a low oxygen tent. Four times a week she endures an ice bath to aid recovery and reduce any inflammations. She also has regular massages. Whereas previously athletes used goose grease as an agent, Radcliffe uses emu oil, the modern equivalent.¹⁴⁵

To what extent does Radcliffe's preparation differ from that of Captain Barclay? Since the nineteenth century sport has applied scientific principles to the training and preparation of athletes. This application, however, has been contingent not only on prevailing scientific knowledge but also the wider sporting context in which the intensity of competition has shaped the demand for this knowledge and resources. In their preparation of athletes early trainers relied on their own intuition and based their judgement on personal experiences. By the Cold War era the Soviet Union especially felt that nothing could be left to chance and poured in vast state resources in the pursuit of Olympic medals. In the West sport has not only become a lucrative commercial activity but, through the intervention of the state, it has become subject to unwieldy managerial and administrative structures that order and organize the lives of those athletes in its pay.

At the same time, scientific knowledge has changed the athletic body, both physically and psychologically. Whereas the mantra of moderation brought fears of staleness from over-training, a greater awareness of the body's ability to endure fatigue and other extremities gave coaches the confidence through this knowledge to place excessive demands on athletes' bodies. While the athletic body may have become a distinct clinical entity by the 1960s, caution should also be taken in using catch-all phrase as social factors, such as gender, ethnicity and class, can also shape an athlete's identity. In particular, for much of the twentieth century the athletic body was constructed in technically and scientifically advanced nations. In large areas of the globe, athletes have not had access to these resources.