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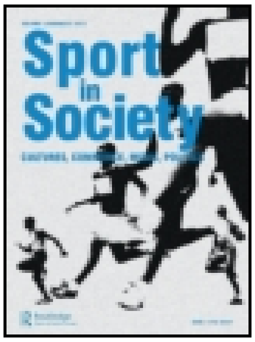

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The 'physiologization' of skiing: the lab as an obligatory passage point for elite athletes?

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ABSTRACT

In *The Pasteurization of France*, Bruno Latour argued that the rise of hygiene was dependent on collaboration between Pasteur, the hygiene movement, scientists and others. He also pointed at the importance of *obligatory passage points* such as the Pasteurian laboratory, to ensure the scientization and rationalization of hygiene. This article argues that there has been a similar process in elite sports, a 'physiologization' where scientists, sport organizations and specialized coaches have transformed training from a deeply personal and experiential matter to something universal and scientific. Physiologists made the test lab an *obligatory passage point* for athletes who wanted to compete on the highest level. Through theories of sportification and science and technology studies this paper analyses the scientization of endurance sports.

Introduction

In his 1988 book *The Pasteurization of France*, Bruno Latour argued that the rise of hygiene was dependent on collaboration between Pasteur, the hygiene movement, scientists and others. He also pointed at the importance of *obligatory passage points* (Callon 1986; Latour 1988, 43 *et passim*) such as the Pasteurian laboratory, to ensure the scientization and rationalization of hygiene. This article argues that there has been a similar process in elite sports, a 'physiologization' where scientists, sport organizations and specialized coaches have transformed training and performance from a deeply personal and experiential matter to something universal and scientific.

The role of science in sports has been growing at least since the 1930s. Over the course of the twentieth century, athletes became an important object of study for physiologists and other scientists, while athletes and sport associations also could make use of the scientific results in their training set-up. Endurance sports were early adopters, both on various national levels (such as the Swedish cross-country skiing team which will be analysed here) and on the international scene. We have seen growing interaction between prestigious centres of sport-related physiology such as the Swedish School of Sport and Health Sciences

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and the Harvard Fatigue Laboratory and sport organizations such as the International Olympic Committee (IOC) and the International Ski Federation (FIS) from the inter-war period and onwards.

Today, the test lab has become an *obligatory passage point* (Callon 1986; Latour 1988). How has this physiologization been achieved? How did relationships between scientists and sport practitioners evolve? What aspects of scientific logic was introduced and why? And finally, how did the interaction affect science and sport?

Through theories of sportification (cf. Guttmann 1978; Yttergren 1996) and science and technology studies (Callon 1986; Latour 1987, 1988; Knorr Cetina 1999) this paper analyses the rationalization and scientization of endurance sports, especially the case of cross-country skiing in Sweden. Physiologists were instrumental in this process, as they wanted to create a universal training model for endurance athletes, based on scientific knowledge. The athletes, on the other hand, held their experiential, local knowledge in high esteem and protested in various ways against the scientization process. Certain aspects of sports and training, such as the issue of high-altitude training and performance or the introduction of new concepts that changed understanding of the body and its performance, will be used as examples here. Specifically, we will look at the discourses about high-altitude training, endorphins and lactic acid.

Physiologists, working on a strong mandate from sport organizations on various levels, made the test lab an *obligatory passage point* (Callon 1986; Latour 1988) for athletes who wanted to compete on the highest level. This ambition collided with the traditional, experiential knowledge of athletes. To further the scientific method within sports, scientists used various *technologies of sportification* (Svensson 2016a, 2016b) to accelerate scientization of training. Examples of such technologies are scientific testing, training logs, training camps, professional coaches and training manuals, and we will focus this article on scientific testing and the test lab. *Technologies of sportification* were meant to both advance scientization of skiing (applied science), and also allow the scientists to gain data for their own ambitions (basic science). At a time when sport science was not a field of its own, tensions between basic and applied research were of great importance. This article will analyse the historical relations between science (mainly physiology) and sport, and we will argue that it was the scientists rather than the athletes who were most interested in interacting.[1]

We use material from the archives of the Swedish Ski Association, The Swedish School of Sport and Health Sciences and Harvard Fatigue Laboratory. Finally, interviews with Swedish former national team skiers and physiologists who were active in elite endurance sports during the 1950s–1970s will shed light on the personal experiences of those involved.

Early scientific interest in endurance physiology and sport

In the first decades of the twentieth century, scientific interest in sport was rather sceptical and focused on potential problems with excessive physical exercise. There were fears that endurance training could cause heart disease and other maladies (cf. Henschen 1898; Dahlstedt 1927). On the other hand, there was also a growing work to enhance the performance of the human body. This work was not primarily focusing on the demand from endurance sports. Rather the impetus came from industry, office work and the military. Some work on exercise, 'fatigue' and work date from the mid-nineteenth century (Rabinbach 1990), but links to athletic performance were few until the 1920s. In 1925 A. V. Hill, a British physiologist who had won the 1922 Nobel Prize in medicine for work on lactic acid and muscle energy, toured the United States with a lecture entitled 'The Present Tendencies and Methods of Physiological Teaching and Research' which was published prominently in *Science* (Hill 1925). Hill's Nobel work and its launch in the US have been regarded as key elements in the breakthrough for exercise physiology as an independent field of study (Berryman 1995; Johnson 2015). In this moment the Harvard Fatigue Laboratory was formed, in 1927, and quickly became a leading and pioneering institution with broad influence, not least through its many visiting researchers that came from many countries around the world including Norway and Denmark and also after it was dismantled in 1947, thanks to the diaspora of former HFL researchers around the United States (Horvath and Horvath 1973).

The roots of the 'Fatigue lab', as it was commonly called, were complex and linked to multiple and diverse research interests among several Harvard faculty members. An important instigator of the lab was Lawrence Henderson whose interest was in what he called 'the environment', by which he meant the intimate conditions that determined human performance, for example, in industry (Henderson 1913). Performance and human physiology were considered primarily an interest of business (Oakses 2015). Hence, the HFL was located in Harvard's business school rather than in, for example, the School of Medicine, although much of the actual work was physiological or, to some extent, psychological and almost all of it was experimental.

Research at HFL was made on a broad, almost bewildering, range of topics. The HFL conducted research on the physiology of high-altitude, hypoxia and the effects of vitamins on long-term survival. It tested gloves, socks, boots, coats and uniforms. It studied fatigue related to sweating, eating and heating. It researched diets, breakfast (with the 'Cereal institute'), and tested optimum distribution of calories throughout the day and the ideal timing and size of meals. Although the early work was inspired by broader ideas of environmental influence and improvement of the performance of industrial workers increasingly the work was turning towards military applications in the latter years of the 1930s and especially during the war (Folk 2010). HFL experimented with pemmican as Arctic food for troops (it didn't work; Kark, Johnson, and Lewis 1945) and pursued work in deserts, tropical jungles, on high-altitude, but did not do much work in oceans or maritime environments (Johnson, Brouha, and Darling 1942; Johnson et al. 1945; Consolazio and Forbes 1946; Johnson and Kark 1946; Belding 1947; Belding et al. 1947).

Military performance physiology was on the one hand an extreme case of what has been called 'human engineering', i.e. an attempt to build a technological shield, or artificially managed micro-climate surrounding the individual human being, along similar lines as the 'environmental' capsules created for space flight with regulated air conditioning, temperature and tailored food rations (Höhler 2015). The soldier should, thus, perform and inhabit what could be seen as a micro version of the artificial landscapes that became part of technocratic landscaping and terraforming during the same period. A key concept in this work was 'environment'. In active use, already in the 1930s, its usage in performance physiology was precisely that of a micro-climate surrounding the individual person. The military and medical understanding of 'climate' and 'environment' in this period developed as environmental physiology, with many lasting military applications, but largely outside of the mainstream post-WWII career of the concept 'the environment' as the object of human pollution and maltreatment (Warde and Sörlin 2015; Warde, Sörlin, and Robin, forthcoming).

Methodologically the HFL was diverse but it privileged hands-on experimentation with humans, rather than laboratory work. It occasionally did massive field experiments with large numbers of soldiers, and it conducted experiments on mental patients. The bulk of the work was in the form of self-experimentation conducted by the scientists themselves, moving heroic, masculine research ideals from the field into the laboratory. Some of the HFL scientists were former athletes and certainly considered athletic performance an ideal for the super performing scientist (Scheffler 2011; Johnson 2015). A leading voice in the articulation of this methodology was Bruce Dill, a physiologist who was also for several years the lab's director. In a string of books and papers he articulated the functional practicalities (for example, the convenient availability of test subjects – the scientists themselves) and the many other virtues of self-experimentation of which he was himself an ardent practitioner (Dill 1938). It is important to note that sports communities were not engaging so much directly with the Fatigue lab. The commissioning influence from the outside, which was considerable, came largely from the Office of Naval Research, the National Science Foundation, and directly from military institutions. While it is appropriate to contextualize the HFL from 1940 as a War institution it cannot be regarded as an exclusively North American undertaking, although its political underpinnings were largely national and strategic. The panorama of HFL activities fits a broader pattern of performance physiology and psychology. The HFL served as an international hub which attracted interest from scholars in many countries and also helped train these for careers in their home countries. But, importantly, HFL scientists also connected to labs and researchers elsewhere, for example, in Europe.

One important connection was with the physiology laboratories of August Krogh (Nobel Laureate 1920) and Johannes Lindhard at the University of Copenhagen, where endurance research was undertaken that influenced HFL scientists. Krogh's core line of research was respiration, a large topic in the first decades of the twentieth century with many medical applications but also for the rapidly growing number of mines and industrial environments with foul air (Haldane and Priestley 1935; Goodman 2007). Incidentally it was also a major interest of Henderson's who studied respiration, and the relationships of gases with blood (Henderson 1928). Krogh's Nobel work was on the alveoles, but interestingly he was equally interested in the respirational exchange between the atmosphere and the ocean, which he studied in Greenland. He developed this work in multiple ways in Copenhagen and trained a group of respiration scientists that were to prove seminal to the continued development of sports physiology (Krogh and Lindhard 1913; Krogh and Krogh 1913; Schmidt-Nielsen 1995, esp. chs 10, 16). One of Krogh's students, Eric Hohwü Christensen, studying respiration like his mentor, had been a visiting fellow at the HFL in 1935 and a member of the high-altitude expedition to the Andes that same year (Tracy 2012). His HFL experience had a lasting influence on his research as he returned to Scandinavia and when he assumed a professorship at the Royal Central Institute of Gymnastics, GCI, in Stockholm in 1940, he brought with him the entire array of experimental styles of work on tread mills and quantifications of human performance that he had been part of at Harvard. In this way endurance physiology research started its remarkable career in Sweden and it soon grew in scope and application far beyond the more limited set of users that the HFL had served.

The environmental micro management of the cold-field soldier was the main objective of the HFL research. It is, therefore, interesting to note the interest in indigenous knowledge of the Lab. There was considerable curiosity among HFL scientists in indigenous materials, foods, mobility, accommodation; more generally, local technologies of survival. HFL reports referred to these materials (e.g. caribou skin) and technologies as templates with superb qualities that modern materials could only dream of emulating. Similar curiosities of the non-modern existed in sport and industrial physiology. Along with the so-called 'rational training' for long-distance Nordic cross-country skiing that grew out of the Stockholm GCI labs there was an interest in traditional Nordic Sami ways of moving with skis. In industrial workplace physiology Taylorist ideals were contrasted with organic and natural ways of organizing bodily movement and the relation to time. As cold science on materials, physical exercise and military warfare developed further these organic and alternative research lines, often rooted in indigenous knowledge, gained in influence and have become significant components in functional materials and diets.

A scientific turn in endurance sports – the case of Swedish cross-country skiing

The early GCI had a wide variety of users. It included the military, but Hohwü Christensen expressly took on a larger mission to serve society at large. Fully in line with Swedish welfare policies of the time this privileged children in schools but also industry and work life at large was important to him (Svensson 2013; Svensson and Sörlin 2015). Sports and athletic performance was not a strong item on his research agenda. However, as the outside interest in the GCI results grew sports communities became curious and by the early 1950s, there were links established between GCI researchers and especially the Swedish teams of cross-country skiing. Over time the collaboration networks between GCI and the endurance sports communities in Sweden grew considerably in size and scope and their quality seem to have been outstanding, possibly among the leading in the world, during the period from 1950s through the 1970s, when other countries had developed similar or larger capacity (Åstrand 1991). As a major contributor of sport-related physiology during the latter half of the twentieth century, the GCI fostered scientists like Per-Olof Åstrand, Bengt Saltin, Björn Ekblom and most recently Hans-Christer Holmberg who rose to international significance.

When Erik Hohwü Christensen had been appointed as the first professor of physiology at the Swedish School of Sport and Health Sciences in 1941, he soon started to do research relating in different ways to sport, physical education and exercise. Importantly, he published in Swedish journals specialized at those subjects which made his research visible to national communities of interest. Many of the articles implicitly or explicitly contributed to the understanding of the body during heavy exercise (e.g. Hohwü Christensen 1943, 1944, 1945). In the first years, science was more interested in sport than the other way around. It took a major crisis for this to change.

After dominating the international scene in the 1940s, led by the 'natural' training ideology of Gösta Olander who was not only a training ideologist but also the legendary manager of Vålådalen alpine station, Sweden failed badly in the 1952 Winter Olympics in Oslo. The Swedish Ski Association sought contact with professor Hohwü Christensen, to get scientific advice and hopefully improve results (Swedish Ski Association 1951, 208). Hohwü Christensen saw several possible benefits of a cooperation, not least getting access to a group of research objects with extreme physiology. This motivation for scientific interest in sport was voiced also in other countries, such as Great Britain (Heggie 2011, 66). The new cooperation meant that physiologists got a strong mandate to perform different test on the athletes, and in time also to write the official training manuals that were the leading written expression of Swedish training ideology. The increasing role of physiology in Swedish endurance training meant a corresponding decline in the more romantic, experiential ideas of natural training which had so far been the leading ideology (Svensson 2016b).

Many of the skiers were hesitant or even hostile to this scientific turn. They felt that their own expertise was undermined, that they were reduced to guinea pigs in the lab (Larsson 2013; Stefansson 2013) and that they did not get sufficient explanation of the test procedures, results and how to use them in their own training (Strandberg 2015). Despite the protests that followed in the first years of interaction between physiologists and skiers, the Swedish Ski Association was determined to let the cooperation with science proceed (Swedish Ski Association 1955, 197).

Sweden may have been one of the leading nations in the field of sport-related physiology in the 1940s and 1950s, but were also part of a larger trend. Physiologists around the world had started to take an interest in extreme bodily performance, and performance under extreme conditions (heat, cold, altitude etcetera). Testing athletes was an important aspect in the formation of this new relationship between science and sport (e.g. Hoberman 1992; Tipton 2003; Howe 2006; Krüger 2006; Johnson 2009; Wrynn 2010; Heggie 2011; Park 2011; Carter 2012; Grant 2013; Park 2014). Scientific interest in sport was on the rise, as were the levels of professionalization, specialization and competition on the international sports scene. But science had not yet become obligatory. Testing was still mostly for the sake of science. This would change gradually during the 1950s and 1960s, and scientific testing would become a standard feature in any elite athlete's career. Let us now turn to one of the examples of this development – the scientific testing of Swedish elite skiers.

Scientific testing of skiers – forming an *obligatory passage point*

How did scientists make the test lab an *obligatory passage point* for elite skiers? First, they came up with methods and technology to perform the tests. Wilhelm von Döbeln, a physiologist working at the School of Sport and Health Sciences in Stockholm, in 1954 constructed a bicycle ergometer for scientific testing. He was optimistic about the possible use of this device for testing physical performance and wrote that 'There is no doubt that devices of this type are very accurate' (von Döbeln 1954). The same year, his colleagues Per-Olof Åstrand and Irma Ryhming published an article where they proposed a new test to check aerobic capacity. They wrote: 'It is suggested that the individual's aerobic capacity per kilogram body weight per minute will give a good measure of his physical fitness' (Åstrand and Ryhming 1954, 221).

Then the physiologists pointed out certain factors as crucial for high-level performance. The main factor was maximum oxygen uptake, or in the nomenclature of physiology, VO_2 max. There were scientific facts suggesting that a high VO_2 max was a key factor to becoming a successful endurance athlete (Saltin and Åstrand 1967, 353). The capacity to measure VO_2 max, combined with emphasis put into this number, transformed the endurance athlete from a mythical figure whose capacities were the result of personal, tacit knowledge (Polanyi 1958), to a product of scientific data and rational training built on that very data.

A key ingredient in this transformation of the athlete was what in football would be called home-field advantage. STS scholar Karin Knorr Cetina (1999) has listed three characteristics of natural objects (let us for the purposes of this analysis assume that athletes can be classified as such) studied in the lab. First, the laboratory does not have to deal 'with an object as it is, it can substitute transformed and partial versions' (Knorr Cetina 1999, 27). If we look at how Swedish physiologists interacted with skiers, this criterion is not easily met when the testing was done in the field. There, scientists actually did have to put up with the skiers as they were. For example, they did not always behave as expected, or even show up. Once brought into the lab, as became more and more common throughout the 1960s and 1970s, surrounding conditions could be more easily controlled by the scientists.

This relates to the second of Karin Knorr Cetina's criterions; that lab sciences do not deal with their objects of interest in those objects natural environment. Instead, the object which to investigate is brought to the lab. There, the scientists can 'manipulate them [the objects studied] on their own terms' (Knorr Cetina 1999, 27). Skiers were brought to the lab and ordered to follow certain diets and sleeping routines, to rid the experiment of all possible sources of disturbance. This is exemplified in a 1957 article, where physiologist Rune Hedman investigated correlations between oxygen intake and carbohydrate usage. Hedman and the skiers went into the lab and measured energy intake, muscular activity and sleep (Hedman 1957, 306, 307). In the lab, quantification of the hitherto tacit knowledge of the skiers shifted the power relations and allowed physiologists to take a more active role in training design.

As pointed out by STS scholar Lorraine Daston (1992, 609), 'certain forms of quantification have come to be allied with objectivity […] because they serve the ideal of communicability, especially across barriers of distance and distrust'. These ideals were crucial at the Swedish School of Sport and Health Sciences. To secure a rational approach to training, professor Hohwü Christensen argued that as much as possible, training should be built on scientific knowledge (Hohwü Christensen 1943, 178). The meeting between this ideology and the experiential, tacit knowledge of the skiers was problematic. Tacit knowledge did not fit into the rational world of Hohwü Christensen and the other physiologists while for the skiers, tacit knowledge of the body based on personal experience was key. Making this tacit dimension explicit and quantifiable was one of the ways in which science took control over training, and it was a certain form of quantification, namely the VO_2 max number, which served as a bridge between enthusiastic scientists and reluctant skiers. For all the resistance put up by the skiers, many were still interested in knowing their VO_2 max (cf. Rönnlund 1967; Rämgård 2013).

Laboratory science also tampers with temporality. It can provoke certain events to take place more often than usual, in order to better study them (Knorr Cetina 1999, 27). Reactions that would develop during several days in normal conditions can be made to occur faster, due to specially designed conditions like lowering the oxygen rate in the lab, while performing hard work. Such interventions were done in several studies at the Swedish School of Sport and Health Sciences (Karlsson and Hermansen 1966; Karlsson, Åstrand, and Ekblom 1967). To relate to another area where experiential and scientific knowledge have clashed, the process of turning medicine into a lab science included using a specialized language (Latin) that the patient could not easily understand (Knorr Cetina 1999, 31). The same strategy was used in sport physiology, when concepts such as lactic acid or VO_2 max became indispensable tools for coaches and athletes. The skiers reacted differently towards this new vocabulary. Lennart Larsson, active in the Swedish national team during the 1950s, says that physiology gave him new ways to express what he previously had known but been unable to formulate: 'I hadn't heard the word lactic acid before but I knew the feeling of numbness when you had pushed too hard during training' (Larsson 2013). Medicine, much like sport physiology, gradually transitioned from a field science to a laboratory science. This transition re-configured the social interactions of patients and doctors (Knorr Cetina 1999, 27). This is interesting when compared to the developments in sport-related science and medicine in Sweden. When physiologists started the interaction with skiers in the 1950s, the skiers were sometimes taken into the lab, but physiologist still had to travel into the (training) field in order to collect data, conduct testing etcetera. Today, specialized departments of sport science have formed *centres of calculation* (Latour 1987) where the data collected at the field by athletes and coaches are analysed. Scientists themselves are no longer obligated to go into the field, even if many still do.

Some skiers used the scientific test procedures as a tool to confirm the personal, bodily experience with scientific facts (Rämgård 2013). Even though skiers still relied on their own perception of physical status and performance levels, some felt a need to have scientific confirmation. When interviewed in 2012, Bengt Saltin mentioned that he had once received a phone call from Assar Rönnlund, one of Sweden's most prominent skiers ever. During the preparations for Innsbruck 1964, Rönnlund had called Saltin and said that he wanted to fly down to Stockholm for a test because he had run unusually fast on his training session that day (Saltin 2012). This illustrates that for some skiers, experiential, personal knowledge of the body was no longer enough. The test had become an *obligatory passage point*, and this was done following the same steps as in similar scientific interventions outside the world of sports, such as the famous meeting between scientists, fishermen and scallops in St. Brieuc Bay (Callon 1986, 202, 203). The Swedish Ski Association and the physiologists had defined a problem (that Swedish skiers were no longer winning at the international scene) and supplied a solution (that the scientific programme of rationalizing training would secure future medals).

In the end, these issues can say something about which kind of knowledge that is valued. When doctors still went to the home and bedside of the patient, the local knowledge of the patient and others present had to be taken into consideration (Knorr Cetina 1999, 30). The same is true for early physiologist visits to training camps of elite athletes. Here the athlete was in control, and the physiologist was an outsider. At the sport science lab or the hospital, the tables are turned. Local knowledge is silenced by the volume of universal, de-localized knowledge. For physiologists, even if they had a personal interest in elite sports, science was the priority. The testing of elite athletes was a tool in the hands of scientific knowledge production. The late Bengt Saltin, one of the leading researchers in the field of exercise physiology and heavily involved with testing endurance athletes, formulated it like this: 'If you have a type of test which you believe have a good forecast value, then you want to try it out and then it is ideal to have access to the real elite' (Saltin 2012). Athletes were often seen as a tool for science, both in their own understanding and in the eyes of the scientists.

Conclusions

The scientific interest in sport has grown tremendously during the twentieth century. From a cautious stance, via an accelerating interest in bodily performance in other areas, to a full embrace of the usefulness of sport science. This development has seen physiologists and other scientists contributing with new understandings of how the body reacts during exercise. They have measured, tested and analysed bodily functions and reactions and built a scientific language for things that previously could only be perceived by personal experience, such as lactic acid, endorphins and hypoxia.

The scientization of sport is part of a larger development. Sports in general tend to go through a process of sportification, and in this process ideas of rationalization, professionalization and specialization are key ingredients. Similar developments occur today in sports that do not have such a long history as many endurance sports. E-sports, for example, have been questioned by scientists much like endurance sports were in the early 1900s, but are now starting to form international organizations, professional teams, specialized training regimes etcetera (e.g. Jonasson and Thiborg 2010; Thiborg 2011; Taylor 2012). In time, we can expect scientists to search for optimal, rational training methods for the sole purpose of enhancing elite e-sport performance.

In the sportification process, and especially in the scientization of training, *technologies of sportification* have been instrumental. Training logs, training camps, scientific testing and training manuals built on scientific knowledge have gradually, through continuous efforts from both scientists and sport organizations, become more important in elite sports (Svensson 2016a). Today, the role of these technologies is even bigger. In fact, it would be unthinkable for a national team skier not to have a detailed training log or to reject scientific testing. These features have become an *obligatory passage point* (Callon 1986, 202, 203; Latour 1987, 129–132, 1988, 42, 43) for anyone who wants to become an elite skier. The Swedish Ski Association and the physiologists at the Swedish School of Sport and Health Sciences have, thus, succeeded in their ambition to make training a matter of science. The similarities with the hygienist legitimization of Pasteurian science are many (Latour 1988, 52).

Simultaneously, there has also been a sportification of science. Elite sports have become an area of scientific study in its own right. While physiologists in the 1940s and 1950s understood their work as basic science, which happened to have potential applications in training, there are now high-profiled research institutions focused specifically on performance in elite sports. This reflects the importance of sport for science – it has become an area of scientific study, and a way to bring in more research funding from the ever-increasing economy of elite sports. Today, skiers are drawn to the *centres of calculation* (Latour 1987), which in this case are the universities where sport science is practised. For example, Östersund is home to the Swedish Winter Sports Research Centre. The same city is also home to several of the athletes in the national teams of cross-country skiing. According to many former elite skiers, the common opinion during the 1960s was that the physiologists had more use of the skiers than the other way around (Svensson 2016a). Science needed the athletes, and sport organizations needed science. Skiers, and other athletes, were more reluctant. Today, skiers are highly dependent on scientific testing to know whether their training is efficient enough.

The Swedish Ski Association and the physiologists succeeded in making the physiology lab at the Swedish School of Sport and Health Sciences an *obligatory passage point*, where skiers had to pass in order to be successful, similar to how a few hundred years ago anyone wanting flour had to pass the mill (Latour 1987, 129–132). The logic was clear – to be competitive, a skier had to train rationally, and rational training must build on science. One of the leading providers of such science at the time was the physiology department at the

Swedish School of Sport and Health Sciences. Nobody was selected to represent the Swedish national cross-country ski team without having passed through their tests.

These tests were gradually institutionalized in different ways. Physiologists were involved at different levels of elite sports and had increasing mandate to design the tests, analyse the results and influence practicalities such as training set-up, regulations etcetera. In the case of Swedish cross-country skiing, scientists successfully replaced the earlier training ideology of natural training with a more rationalistic and scientific approach (Svensson 2016b). In the international scene, they contributed directly to the understanding and regulation of high-altitude training and performance at high-altitude events such as the Winter Olympic Games in Squaw Valley 1960 or the Olympic Games in Mexico City in 1968 (Kasperowski 2009; Svensson and Sörlin 2015). Further institutionalization of the scientific testing apparatus was evident in the formation of special education for presumptive elite skiers in Sweden. The Riksidrottsgymnasium, introduced in 1971, quickly became another *obligatory passage point* (Callon 1986; Latour 1988) for those who aimed at a career in cross-country skiing. By the early 2000s, more than 90 per cent of the national team skiers passed through the system.

If this is the new *obligatory passage point*, then it has replaced an earlier, less scientific one. Until the mid-1960s, almost all male elite cross-country skiers in Sweden and Norway had a background in or were still active within forestry (Gotaas 2010; Svensson 2016a; Sandbakk 2017). The hard, physical work in the forest was such an advantage because of the upper-body strength it gave, that those who were not foresters either changed their line of work. One example is the 1950s and 1960s skier Rolf Rämgård, who used to work in a bakery (Rämgård 2013). Others remained the exception that proved the rule, like Nils Karlsson who worked at the Mora knife factory and was called Mora-Nisse throughout his career in the 1950s (Karlsson 1953). These skiers had to compensate for the lack of physical workload with extra training to strengthen their upper-body. A baker could not stay competitive in the long run against forestry workers, which is ironic given that there is now a professional ski team called Team United Bakeries. For the female skiers, forestry was rarely an option. Instead, many of the Swedish national team skiers in the 1960s worked at farms, local grocery stores or other jobs where heavy lifting and general use of upper-body strength was a daily routine (cf. Gustafsson 2013; Martinsson 2013; Strandberg 2015). Forestry was gender coded as male, but the need for upper-body strength was not.

The forest played an important role not only as a workplace but also as a training arena. While the physiologization and sportification (professionalization, specialization) of endurance sports rendered forestry work obsolete as a form of training, it could not dissolve the relationship between athlete and forest completely. Even the science-based flood-lit tracks for running and skiing that were introduced in Sweden in the 1960s were situated in the forest (Qviström 2016). So, they took the forest out of the athlete but could not take the athlete out of the forest (other than for brief periods of testing in the lab). Today, we see innovative co-constructions of training knowledge through both scientific and traditional knowledge. While self-monitoring through technical devices such as GPS watches, pulse measuring devices and devices measuring cadence, watt and what not, we also see increasing interest in trail running, off-trail and other types of training that takes place in non-specialized landscapes. These two trends are not mutually exclusive, but are rather part of a co-construction of training knowledge that has been going on since science entered the world of sports and training. The *technologies of the self* that Michel Foucault discussed (Martin, Gutman, and Hutton 1988) is at the core of the quantified self-movement, but there is also a strong trend of sport-related activities in nature, such as trail running in mountains or forests. In many ways, it is a merging of the traditions of natural training and scientific training, which historically have been quite different in terms of ideology and epistemology, not least in whether to regard landscapes as a vital ingredient in training or as an external factor that made comparisons and measurements less accurate (Svensson 2016a).

In Vålådalen, the famous Swedish mountain valley where skiers and other elite athletes (such as Ingemar Johansson, Floyd Patterson, Gunder Hägg and Michel Jazy) have come to train since the 1930s, there is a special tree. It is a pine tree that was used by the Swedish training ideologist and manager of the Vålådalen alpine station, Gösta Olander, as a point of reference during training sessions. Olander, himself a sceptic when it came to scientific training and hesitant to rigorous measuring (Olander 1948), still needed something to make comparisons between different athletes and training sessions. This tree eloquently sums up the merging of science and sport, of labs and landscape, of measured data and personal experience, or to paraphrase Latour; the physiologization of skiing. In the 1950s, no skier could reach the top of the Olympic podium without passing through the forest. Today, no elite athlete can reach the top without passing the *obligatory passage point* of the test lab. And yet, very few endurance athletes go there without taking the detour through the forest either.

Scientization is also spreading to amateur sports and several of the technologies described in this article have been adopted by those who pursue endurance sports as a hobby or pastime, that was popularized in Sweden not least with the diffusion of television in the 1960s (Bolling 2005). The purpose is of course to make training more effective but also to improve health and enhance joy. This is an interesting area to explore in further research. The 'training prescription', to model elite training methods but on a modest level, in order to improve certain conditions or as a preventive medicine method started becoming practised in the 1980s and now a regular feature. Research on endogenous human substances of morphine character, such as dopamine or endorphin, developed in the 1970s (cf. Terenius 1973; Snell 1978), and, more recently on cannabinoids (Fuss et al. 2015) have become much used in the narrative cultures of endurance sports and lended an aura of science to physiological experience. Perhaps it would be useful to think of not only competitive elite sports as undergoing a physiologization. Similar processes occur on a wider basis and fits a pattern where causation and explanatory value is moved from social, economic and cultural conditions to the individual and even his or her body. In that regard, the history of physiology and sport stands in the middle of some of the large issues in current social and political discourse.

Note

1. We are of course aware that other strands of science and scholarship have also increasingly affected sports and athletic performance, including endurance sports. This is perhaps most obvious in psychology, and one may well talk of a similar, but slightly later, process of psychologization of sports performance. But one could also think of, for example, sociology, anthropology, strands of technology such as materials research, economics, education, organization research, and parts of the humanities. The general tendency is that more and more kinds of knowledge are deemed in one way or the other relevant to enhance performance within a given area of sports. The Swedish Centrum för idrottsforskning (CIF; The Swedish Research Council for Sport Science), which serves as specialized funding agency considers a priori all knowledge fields as relevant potential recipients for their funding. The trend in CIF is that non-traditional areas (outside physiology and psychology) are growing.

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