

Sigmund Loland and Arthur Caplan:

**The ethics of technologically constructed hypoxic environments in sport**

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## **Abstract**

With the use of technologically constructed hypoxic environments (TCHE) in soccer as our case, we propose four check points from which to evaluate new performance-enhancing technologies in sport. These are; I) is the technology beneficial, II) is it safe, III) can fairness be assured, and IV) is the technology in line with the spirit of or rationale for sport? The use of TCHE is ambiguous. On the one hand, in situations with grave inequalities between teams due to lack of acclimatization of one team, TCHE can be an efficient means to even the playing field and out of concern for athlete welfare and health. On the other hand, if used as a pure performance-enhancing means to enhance the oxygen-carrying capacity of the blood independent of altitude, it belongs to a category of expert-assisted performance-enhancement that may challenge athletic autonomy and the responsibility for one's own performance and, hence, the spirit of sport.

## Introduction

For centuries science, medicine and technology have provided athletes, both elite and ordinary, with various means to improve their performance. Golf clubs, football helmets, ski waxes, bobsleds, pole vaults, tennis racquets, weight equipment, cricket and baseball bats, archery bows, soccer balls, ice skates, and other equipment have all seen considerable changes in response to scientific knowledge. Training techniques including diet and methods of exercise have rapidly evolved. Nearly all of these changes have contributed to improvements in performance—some of which athletes of earlier eras could not have dreamed of attaining no matter how hard or long they trained.

Now a new generation of technology is upon us. Drugs and pharmaceuticals are available which can improve strength, balance, endurance and attention. Moreover, technologies that make use of the body's natural adaptive responses to the environment have been developed. For instance, since the early 1990s, athletes have used technologically constructed hypoxic environments (TCHE), such as hypoxic chambers or hypoxic tents, with the intention, at least in part, of increasing red cell mass, maximum oxygen uptake and thereby endurance and performance.

The use of devices such as TCHE-technology has led to debates in the sporting community.<sup>1</sup> Some have focused on bio-medical and functional aspects. Is TCHE really performance-enhancing? If so, under what conditions, and how can its effects be explained? Are there health risks involved? Other debates raise ethical questions. Is the use of TCHE in line with sporting ideals, or with what the World Anti-Doping Agency (WADA) calls 'the spirit of sport', or does it contradict such ideals?<sup>2</sup>

How are we to think about these new technologies? What are valuable technologies in sport, what are acceptable technologies, and where ought we to draw the line concerning the unacceptable?

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<sup>1</sup> See the articles in this issue.

<sup>2</sup> For discussions of the ethics of TCHE-use, see for example *Journal of Medical Ethics* (2005) 31: 112-115, and Loland and Murray (2007).

This paper seeks answers to these questions. More specifically, with the use of TCHE as a real case, we develop a framework for thinking about the ethics of performance enhancing technologies in football and other sports.

### **A note on the nature of ethics**

It is important to understand that there is no self-evident or obvious answer to the question of whether it is right to use high altitude simulating tents or any other new technology. The answer to questions concerning the use of technology in sport is not written in some essentialist, Platonic form of what sport ought to be, Nor is there a 'God-given' ethos handed down from on-high about what role technology should play. There is no 'natural' or 'given' answer to be had. Even very dangerous drugs or highly risky training techniques could be permitted if we chose to allow them. The answers to what is allowed, what is permitted and what is fair in sport are conventional and, as such, must be the subject of critical examination, debate and rational discourse.

In other words, decisions about technology are in our hands. This is not to say we cannot reach consensus about what to permit and what to exclude. But we need to rely on persuasive arguments about why we compete and what we believe we are trying to accomplish in and with sports.

In order to reach sound conclusions about the limits, if any, to the use of technology in sport, it is necessary to begin with agreement about the facts. Sound normative reasoning relies upon mutual understanding of the facts underlying a particular question (Caplan 1998). And for any consensus to be effective it must involve all those with interests in the normative issue – in this case whether TCHE ought to be permitted in football. While some voices merit more respect due to differences in experience or because those who put their bodies on the line in the actual performance of a sport have a greater stake in the answer, seeking consensus requires an effort to solicit a wide variety of opinion.

Consensus also requires some effort at consistency with previously established rules and

boundaries in that like cases ought to be treated alike if decisions about the use of technologies in sport are to be accepted as fair.

### **The spirit of sport**

Questions concerning the acceptability of particular performance-enhancing means and methods are related to the discussion of doping due to the consistency required to achieve consensus. Not surprisingly, therefore, the debates on TCHE have attracted the attention of WADA. In 2006, TCHE was reviewed according to existing criteria for substances and the established rationale for being placed on the WADA Prohibited List. These criteria are (1) scientific evidence or experience which demonstrates that the method or substance has the potential to enhance, or enhances, sport performance; (2) medical evidence or experience suggests that the use of the substance or method represents an actual or potential health risk to the athlete; and (3) the use of the substance or the method violates the spirit of sport.<sup>3</sup>

In terms of criteria (1), WADA's scientific committee stated that TCHE '... can significantly enhance performance when properly applied, by increasing the endogenous production of EPO with a subsequent elevation of red blood cell production and a better oxygen transfer to the muscles.' When it comes to health issues, the WADA scientific and medical committee concluded that, provided proper medical supervision, moderate altitude simulation, and reliable equipment, '... no significant signs of health risks were reported.' The key issue then became whether the use of TCHE can be said to be a challenge to what WADA refers to as 'the spirit of sport'.

In the so-called 'fundamental rationale' for the WADA Code, 'the spirit of sport' is defined as,

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<sup>3</sup> See article 4.3 in the WADA Code, [http://www.wada-ama.org/rtecontent/document/code\\_v3.pdf](http://www.wada-ama.org/rtecontent/document/code_v3.pdf). Accessed September 30, 2007

‘...the celebration of the human spirit, body and mind, and is characterized by the following values:

- Ethics, fair play and honesty
- Health
- Excellence in performance
- Character and education
- Fun and joy
- Teamwork
- Dedication and commitment
- Respect for rules and laws
- Respect for self and other participants
- Courage
- Community and solidarity’<sup>4</sup>

These are general references and hard to operationalize when it comes to concrete cases of performance-enhancing technologies. With the strong drive towards maximal performance in elite sport, and with rapid scientific and technological innovation, WADA faces a constant challenge in knowing where to draw the line. In addition to relevant facts about the means under consideration, there is a need for more precise interpretations of the concept of the ‘spirit of sport’. The key issue seems to be what is the point of an athletic performance.

### **Athletic performance**

Athletic performances are complex product of a high number of genetic and extra-genetic factors from the moment of conception to the moment of performance. As with most human phenotypes, the distinction between genetic and environmental influences is hard to uphold. Still, for normative analyses, the distinction may make sense.

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<sup>4</sup> [http://www.wada-ama.org/rtecontent/document/code\\_v3.pdf](http://www.wada-ama.org/rtecontent/document/code_v3.pdf), p. 3. Accessed September 30, 2007

Genetic factors can be understood as the predispositions for developing the relevant phenotypes for good athletic performances. A person with predispositions for developing, for instance, unusual speed, endurance, or advanced movement techniques in sports in which these are critical qualities, is usually characterized as ‘talented’ at these sports. From the perspective of a population, talent in this sense is distributed in the so-called natural lottery and based on chance.

Athletes develop talent through gene-gene-environment interaction. Environmental influences range from the early nurture and the gradual development of general abilities and skills, to being raised in a particular environment and climate which present particular opportunities to engage in sports, to specific training and the learning of the technical and tactical skills of a particular sport. Environmental influences are based in part on luck; a person with a talent for swimming is born next to a public pool and happens to come under the supervision of a good coach. But, primarily, extraordinary success is based on an athlete’s own efforts; the swimmer, runner or gymnast realizes their talent through hard training over many years.

There are various views on what athletic performances ought to be all about. Below we discuss a key tension between two set of interpretations – we will call them ‘thin’ and ‘thick’ interpretations - that seem to be expressions of the basic tension in the normative thinking of competitive sport today.

### **Thin interpretations**

On what can be labeled the thin interpretation of the point of athletic performance the definitions of athletic performance as found in the existing competition rules are sufficient. Rules against the use of hands in soccer, or kicking in handball, or pushing other runners in track and field-races, are to be kept and honored as they are the constitutive rules which define a framework without which evaluation of performance and the very understanding of the game would not be possible at all. Thin interpretations

often include a (Kantian) fairness ethos. Rules are to be kept not only due to the need to define the sport and for valid evaluations of performance and outcome but out of respect for other competitors as ends in themselves. Outside of competitions, however, thin interpretations reject restrictions on performance-enhancing means and methods other than from what is regulated by general law.

Thin interpretations come in many versions, from what can be labeled harsh realism in which doping is considered a problematic but necessary consequence of the logic of elite sport (Black and Pape 1997), via versions based on strong anti-paternalism which emphasize individual autonomy (Brown 1990, Tamburrini 2000), and to so-called neo- or trans-humanistic perspectives which promote radical ideals of human enhancement and performance with the help of modern bio-technology (Fost 1986, Miah 2004). From the thin interpretation perspective, appropriate TCHE-use is considered a fine-tuning of the human organism and as a reinforcement of the true, transcending spirit of sport.

Counterarguments to thin interpretations are that they are sociologically naïve and contra-productive. Lifting all restrictions on performance-enhancing means and methods may leave athletes in vulnerable positions and reduce drastically their autonomy (Loland 2001). However, in a situation with fully informed athletes who are capable of free and rational choices, the thin interpretation can be morally defensible. Perhaps visions of elite sport as spheres for human bio-technological self-construction are closer to future realities than many tend to believe?<sup>5</sup> Still, the thin interpretation of what is permissible in sport is not one that has achieved anything close to consensus in any major sport.

### **Thick Interpretations**

An alternative can be found in thick interpretations in which sport rules are considered to define not just a particular framework for in-competition evaluation of performance but as expressions of ideals with clear and desired implications outside of the competitive setting. Thick interpretations range from the United Kingdom's Ideal's Program,

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<sup>5</sup> For discussion of various visions in this respect, see Tamburrini and Tännsjö (2005).

traditional norms of martial arts as exemplified in karate and sumo, Olympic and Paralympic ideology, and WADA's views of 'the spirit of sport', to more scholarly treatments of the purpose of sport such as those of Morgan (1994), Loland (2002), and Simon (2004).

The initial core assumptions of the thick interpretation of the spirit of sport are not dissimilar to that of the thin interpretation. Athletes are considered free and responsible moral agents. The consequences drawn, however, are far more extensive.

To realize athlete potential for moral agency, training and competition must cultivate the athlete's responsibility for performance. Performances should be the result of athletic effort. Competitive sport is about individual merit. Only in this way, the thick interpretation argument holds, can sport realize its spirit as a particular sphere for exhibiting human excellence. And, of equal importance, only through rewarding individual effort can sport offer moral lessons to society.

Thick interpretation ideals seem to have a regulative function in the rule systems of most sports. For instance, inequalities that athletes can not influence with training and for which they can not be claimed responsible, such as inequalities in sex, age and body size where these inequalities matter to performance, are eliminated or at least compensated for with the creation of competitive categories.

There is of course much room for improvement here. In some sports, there is a need for more classification, other sports classify too much. For instance, basketball and volleyball in which body height is crucially important to succeed there is a rationale for classification according to height. In other sports such as in rifle shooting or archery, biological sex seems to be irrelevant to performance and sex classification ought to be abandoned. Moreover, the thick interpretation has considerable critical force beyond classification issues. If taken seriously, it would have radical consequences for the regulation of inequalities in financial, scientific and technological resources behind

athletes and teams. But these require more extensive discussion about fairness and justice in sport (see Loland 2002).

Although significantly challenged by thin interpretations, thick interpretations in one version or the other seem to be generally accepted in the sport community and on the part of the public. The ideal of athletes as moral agents with responsibility for their own performances is widely accepted. If this is so, what are the implications of thick interpretations for performance-enhancing technologies in general and for TCHE-use in particular? Four principles can be adduced that seem relevant in answering this question.

**I: The technology must produce verifiable benefit—it must be demonstrably efficacious**

To be utilized and adopted sport technologies and training techniques must be subject to rigorous scientific analysis. Scientific warrant is the first ethical principle of performance enhancement. No matter how often a technology is used, no matter how many testimonials are given on its behalf, it makes no sense to invest time, money and sometimes to create inconvenience and risk to pursue ideas that do not work.

Since many more athletes live at low altitudes than very high the focus on performance impairment tends to be on what happens when competition takes place at an unusually high altitude. As is evident from the papers in this issue, it is clear that altitude inhibits performance. The higher one goes, the more rapidly this is done the more aerobic capacity is diminished. This has a distinct impact on aerobic sports such as long-distance running and cross-country skiing. It may have a different impact on those who try to play football in that cognition and fine-motor based technique may be impaired which may limit performance as much as the burden imposed on aerobic performance by very high altitude. For an individual coming from low altitude, playing football in locations such as the Bolivian cities of La Paz or Toluca means that the performance is likely to suffer.

One way to compensate for very high altitude is to use a combination of technology, acclimatization and training techniques. Interestingly not every technique used stands up to the test of science. For example, intermittently breathing nitrogen by mask at sea level does not improve performance. Ultra high altitude training causes harm in some groups susceptible to altitude sickness.

In football less is known about altitude training and technology than would be ideal. Often limited data is all that is available derived from small numbers of athletes in a narrow range of sports. The data may not reflect the racial and ethnic diversity present when teams come to play nor does the available data reflect rapidly changing environmental circumstances such as temperature, humidity, shifts in sleep patterns or diet. This means that caution ought be the order of the day in making recommendations to football players and coaches about the technological benefit to performance they can achieve using TCHE or high altitude training or both.

## **II. Safety First**

In sport risk is a reality. Many sports are inherently filled with risk and the athletes have the scars, broken bones and pulled muscles to prove it. And part of the fun of watching sport is to see how athletes face and master risk (or fail to do so).

That said, risk cannot and should not overwhelm the best interests of the athletes who engage in sport. Respect for the health, well-being and dignity of the athlete must be a paramount consideration in thinking through the ethics of any proposed technological or training innovation. Those performance enhancing drugs that cause cancer, sterility or other health problems must be banned since the pressure to use them could lead to situations where the athlete sacrifices his health or a coach or owner demands such a sacrifice for short-term performance gain. Rules that allow the drama and skill of sport to be in evidence but which also minimize the prospect of serious injury and disability ought be implemented in every sport be it seatbelts and crash cages in auto-racing or keeping athletes adequately hydrated in football and basketball.

Risk can take the form of harms that are emotional, and psychological as well as physical. Having to live in a very confined space for weeks or months to maximize aerobic performance might well violate an athlete's sense of well-being or psychological stability. Asking athletes to wear burdensome equipment at altitude while they engage in football may be both an affront to the elegance and dignity of the athlete as well as a source of very real physical risk in a high-contact sport.

If properly used, TCHE does not seem to imply any direct health risks (Levine 2006). Still, in thinking about any performance enhancing technology all variety of harm must be weighed-both short and long-term. It is especially important to assess the potential harm done to young athletes and children who often may not have the ability to stand up to parental, peer or coaching pressures or may simply wish to emulate their heroes despite the fact that they may be more vulnerable to harm.

### **III. Justice and Fairness**

Sport competitions ought to be fair and just. Key requirements on fairness concern equality of external conditions, classification of athletes in which inequalities in, for instance, size, age and sex are eliminated or compensated for, and equal access to technology and training expertise assured. In the context of performance-enhancing technologies, it seems unfair that only some athletes have access to these technologies and not others. The premise, of course, is that the idea in sport is to evaluate an athlete's talent and skills, and not inequalities in their support systems and technologies. Admittedly this principle is not always honored in the sporting community but deviating too far from it would completely undermine the competitive nature of sport.

The implications of requirements on fairness are obvious. If a performance-enhancing technology is really working and only a few athletes have access, the situation is unfair. In the case of TCHE, it is obvious that if the technology is effective and safe, and if it is

considered in line with the spirit of the sport, FIFA has an obligation to provide for equal access both to equipment and to the knowledge about how to use it .

#### **IV. Spirit of sport and rationale for sport**

We have proposed two interpretations of the spirit of or the rationale for sport—thin and thick. As a social practice, sport has certain inherent norms and values, developed over decades and even centuries, that indicate its desired significance for individuals and society. In our interpretation, we emphasize the idea of athlete autonomy and responsibility for performance using the thick interpretation of the purpose of sport. What are the implications of this for performance-enhancing technologies in general and for TCHE-use in particular?

Many performance-enhancing technologies are of key value and constitutive of sport. Athletes interact in admirable ways with sport equipment such as skis, bikes, skates, and soccer balls. In training and preparation, athletes also interact with a variety of technologies that include weights, training machines, and technological devices that measure air and water resistance as related to movement patterns and body positions, et cetera. Successful outcomes of these interactions depend upon athletic effort and skill. As long as there is equal access among competitors, they are in line with and to a certain extent enforce the spirit of sport.

However, most performance-enhancing technologies, such as the use of most of the substances on WADA's Prohibited List, are considered to provide performance-enhancement without athlete effort and skill. Their successful use depends primarily upon their correct administration usually guided by external expertise. In addition, most of these means imply significant risks of harm. Upon their use, athletes end up in vulnerable positions in which the nature and consequences of technology use must be carefully overseen by others. Athlete autonomy is threatened. Sport, as a measure of athletic effort and performance, loses its significance. Hence, many argue that potentially harmful

expert-administrated performance-enhancing means and methods should be banned. In this interpretation of the spirit of sport, there is strong support for anti-doping.

TCHE is a kind of expert-administered technology. This does not mean that TCHE can be equated with doping. Banned performance-enhancing drugs such as anabolic steroids or EPO meet all three WADA-criteria, including the risk of serious harm. TCHE-use is reported to create little or no health risk. Some even argue that its performance-enhancing effects are marginal. The physiological adaptive responses to TCHE-use is radically different from the workings of doping means such as EPO or blood doping that bypass normal physiological feedback control mechanisms and adaptive responses (Levine 2006). No athlete or team can perform well without talent and the cultivation of talent through intensive training, but TCHE-use can be the significant factor that distinguishes a winner in the end. However, as long as TCHE-use does not have strong performance-enhancing effects, the decision of WADA not to ban the technology seems as a reasonable one.

However, to protect athlete autonomy and empowerment and encourage athlete responsibility for performance, expert-administrated technologies such as TCHE should be continuously and critically discussed and evaluated. The case against a ban at present is not strong. But the case for encouraging, promoting or demanding the use of TCHE is not strong either.

### **TCHE in contexts other than pure performance enhancement**

Does this mean that there is no place for TCHE in football or other sports? When it comes to football, the consensus statement in this volume is clear: TCHE is not considered to be of any real significance.

If TCHE-use exerts only marginal performance-enhancing effect but is of significance to athlete health and welfare, appropriate use can be within the spirit of sport. If competitions take place in high altitudes, if the use of TCHE is of crucial significance to

athlete health and welfare, and if the technology is provided for on an equal access basis, its use should be considered. But again, based on principled concerns about the challenges of performance-enhancing technologies that do not require athlete effort and skill, the thick interpretation of the spirit of sport encourage a restrictive attitude. Indeed, it is problematic whether sport events should take place at altitudes that subtly coerce athletes to use TCHE whether they want to or not.

Should the compensatory use of TCHE be necessary at all in a sport such as football? If adherence to the goal that football be played wherever significant human populations dwell, it must be understood that this goal may create the need to use TCHE—a need which could be moderated or eliminated by the thoughtful selection of playing venues. TCHE only activates a (limited) physiological adaptive response and is not recommended as acclimatization for playing football at all.

What can be said of the use of TCHE outside of sports? There is of course nothing wrong with TCHE per se. To the contrary, the technology is crucial in hypoxia research and in providing valuable basic and applied knowledge of the physiology of altitude. Moreover, in a series of applied settings from aviation to physically strenuous work in high altitude as in alpine rescue, the use of TCHE seems both appropriate and important. This underlines a more general ethical point.

To be able to deal in reasonable ways with enhancement technologies in sport and society, it is absolutely necessary to differentiate between the logic and goals of different human practices. The logic of science, aviation or alpine rescue is primarily an instrumental one. Outcomes in terms of knowledge, or human welfare and human life, justify their existence. The ideal logic (or spirit) of sport is a different one. The rules of sporting games define the removal of the most efficient means to reach a goal in favor of less efficient means (Suits 1973). Outfield soccer players are not allowed to play the ball with their hands; a handball player can not kick the ball; a hurdle runner has to run over and not around the hurdles. These obstacles are what make up sporting games and

provide them with meaning and value in themselves independent of their outcome which in this sense is trivial.

## **Conclusion**

We propose four critical questions as guidelines from which to evaluate new performance-enhancing technologies in sport. These are; I) is the technology beneficial, II) is it safe, III) can fairness be assured, and IV) is the technology in line with the spirit of or rationale for sport. The use of TCHE is ambiguous. For the specific case of acclimatization for football in altitude, the consensus statement in this issue does not recommend TCHC-use. More generally in situations in competitions between individuals or teams due to lack of acclimatization, TCHE can be an efficient means to even the playing field and to protect athlete welfare and health. On the other hand, if used as a pure performance-enhancing means to enhance the oxygen-carrying capacity of the blood independent of altitude, it belongs to a category of expert-assisted performance-enhancement that should be discouraged since it challenges athlete autonomy and responsibility for performance and, thus, the interpretation of the spirit of sport which is currently widely accepted as valid.

## **References**

Black, T. and Pape, A. The Ban on Drugs in Sport: The Solution or the Problem? *Journal of Sport and Social Issues* 1997: 21: 83–92.

Brown, R. M. Practices and Prudence. *Journal of the Philosophy of Sport* 1990: XI: 14-22.

Caplan, A. C. *Due Consideration*. New York: John Wiley & Sons 1998.

Fost, N. C. Banning Drugs in Sport: A Skeptical View. *Hastings Center Report* 1986: 16: 5-10.

Levine, B. Should “Artificial” High Altitude Environments be Considered Doping?  
Scandinavian Journal of Medicine and Science in Sports 2006: 16: 297-301.

Loland, S. Technology in Sport: Three Ideal-typical Views and Their Implications.  
European Journal of Sport Science 2001: 2: 1-10.

Loland, S. Fair Play in Sport. A Moral Norm System. London: Routledge 2002.

Loland, S. and Murray, T. H. The Ethics of the Use of Technologically Constructed  
High-Altitude Environments to Enhance Performances in Sport.  
Scandinavian Journal of Medicine and Science in Sports 2007: 17: 193-197.

Miah, A. Genetically Modified Athletes. Biomedical Ethics, Gene Doping and Sport.  
London: Routledge 2004.

Morgan, W. J. Leftist Theories of Sport: A Critique and Reconstruction. Urbana: Illinois  
University Press 1994.

Simon, R. L. Fair Play. The Ethics of Sport. Boulder: Westview Press. (2. ed.) 2004.

Suits, B. The Elements of Sport. In: Osterhoudt, R. G. (ed.) The Philosophy of Sport.  
Springfield: Charles C. Thompson 1973.

Tamburrini, C. ‘The Hand of God.’ Essays in the Philosophy of Sport. Gothenburg: Acta  
Universitatis Gothoburgensis 2000.

Tamburrini, C. & Tännsjö, T. (Eds.) Genetic Technology and Sport: Ethical Questions.  
London: Routledge 2005.

