

The DREAM Gene for the Posthuman Athlete: Reducing Exercise-Induced Pain Sensations Using Gene Transfer

By Professor Andy Miah, email@andymiah.net, University of the West of Scotland.

CITATION: Miah, A. (2010) The DREAM Gene for the Posthuman Athlete: Reducing Exercise-Induced Pain Sensations Using Gene Transfer, in Sands, R.R. and Sands, L.R. (Eds.) *The Anthropology of Sport and Human Movement: A Biocultural Perspective*. Lexington Books, New York. pp.327-341, *please obtain published version*.

Abstract

Downstream Regulatory Element Antagonistic Modulator, or DREAM for short, is a protein critical to pain sensations experienced by organisms. Recent research has suggested that it might be possible to exploit this genetic modulator of pain for the purpose of pain management (Cheng et al., 2002; Cheng and Penninger, 2003). This paper discusses the ethical implications of modulating DREAM expression for sport; to advance the debate on what constitutes a legitimate method of performance modification. Initially, it is argued that DREAM presents a more complex problem for anti-doping authorities than other methods of gene doping, since it cannot easily be characterised as enhancing or therapeutic. Indeed, the basis of this distinction is criticised by exploring a biocultural definition of health. On this model, which seems unlikely to be endorsed by anti-doping authorities, but, nevertheless, which is perpetuated by sport physicians, the use of DREAM manipulation would seem more difficult to prohibit on medical grounds. Its use is consistent with a medical desire to alleviate suffering, even where it is self-induced. A similar dichotomy exists when discussing the relevance of pain from a sporting perspective. While one might presume that the ethics of sport is such that any legal mechanism to improve performance is desirable for an athlete, pain tolerance appears to have a symbolic value that would undermine the usefulness of DREAM manipulation. This tension demonstrates greater complexity to the debate about the role of technology in sport and its ideological connotations about what it means to be an athlete.

Key concepts: ethics, pain, enhancement, sport, genetics

Introduction

Since the discovery of the double helix by Francis Crick and James Watson in 1953, the gene has become an important and powerful symbol in society. Genetic science is seldom out of the news and has been the inspiration for many controversial descriptions about our imminent “posthuman future” (Fukuyama, 2002). Indeed, various examples can be cited that describe a *contested* history of genetic technology. Even the discovery of the structure of DNA was steeped in controversy over who could claim credit for having identified its *twisted helix* structure (Hubbard, 2003).¹ Sport is no exception to this controversy. The nature/nurture discussion about athlete performance is ongoing and its veracity is fuelled by the continued acceptance of performance as a guiding value in elite sport, which prioritises quantifiable achievements of athletes over qualitative ones. To this end, sport scientists are constantly trying to find ways to develop a better understanding human biology in an effort to legally enhance performance.

In recent years, a number of ethicists have begun to discuss the role of gene transfer technology in sports (Miah, 2004; Munthe, 2000, 2002; Tamburrini, 2002). Such discussions have questioned the ability to maintain anti-doping policies in an era of genetic modification and have revealed some of the complex circumstances that arise as a consequence of genetic modification. For example, one challenging situation for anti-doping agencies would be the prospect of the genetically modified athletes who could not be called cheats, just because they were modified before they were born. While such troublesome cases might not occur until some time in the distant future, they bring into question what should be the basis of inclusion within elite sports. Such circumstances require sport policy makers to recognise the broader implications of genetic technology and radically re-think sporting values.

The literature says little about the social and cultural significance of genetic modification in sport, despite some obvious overlaps. The sorts of questions that have dominated the discourse in sport have been the ethical legitimacy of genetic modification, where it is usually conceptualised as a form of performance enhancement. Alternatively, discussions have been concerned with the ideological implications of characterising sport performance as genetically determined, for the potentially divisive consequences such conclusions might have. As well, authors have attempted to place this in an ideological context, discussing whether the tendency towards excessive achievement in sport leads necessarily to a technolo-

gised future for athletes. Such arguments introduce notions of cyborgism (Butryn, 2003a), transhumanism (Miah, 2003), and posthumanism (Butryn, 2003b) as a way of characterising the postmodern athlete. However, athletes do not fit neatly into this technological characterisation, since naturalness and being human are also championed as athletic virtues, where the use of doping undermines these values. Moreover, this paper aims to suggest that one cannot easily relate technologisation with a desire to transcend human limits. Indeed, one could argue that there is resistance to the technologisation of sport, on this basis. Consequently, how elite sports reconcile the use of high-technology and its resistance has led to interesting debates (Miah and Eassom, 2002).

Nearly all of these discussions problematize the legitimacy of enhancement in sport, specifically concerned with the distinctions between acceptable and unacceptable methods of performance modification. This paper is less concerned with that distinction, and rather, inquires into the legitimacy of what would typically be described as therapeutic modification, specifically, pain management. This example is particularly intriguing since it has an ambiguous status as both an example of high-technology (genetic modification) and, as an application, something that is morally conservative (reducing pain). Where sports authorities have dismissed genetic enhancement or 'gene doping' as unequivocally unethical, the use of gene therapy is considered to be legitimate. Potentially, the genetic modification of pain sensations could be conceptualised as therapeutic, yet it would have clear implications for the capacity of an athlete to perform in sport, which would most likely make it controversial.

In this context, the paper proceeds by explaining the scientific research underpinning the potential genetic manipulation of pain sensations. This research is then placed into a medical context, from which I will discuss how the possibility for reducing pain sensations might be medically desirable and ethical consistent with what is athletically relevant in sport contests.

DREAM, for Short

Downstream Regulatory Element Antagonistic Modulator (DREAM) is a "critical repressor for pain modulation" (Cheung, 2002 January 11), which means that it has some role in how we interpret the sensations of

pain. Recent research suggests that it could provide useful information about the function of pain and how it might be managed, which could revolutionise how pain is addressed by medicine (Cheng et al., 2002; Cheng and Penninger, 2003). The DREAM protein functions by blocking the production of prodynorphin (the precursor to dynorphin, an endogenous analgesic), which is a chemical produced in response to pain or stress. Research with mice suggests that the absence of *DREAM* (the gene) leads to increased levels of dynorphin and a decreased sensitivity to inflammatory, acute, and neuropathic pain.

The possible applications of this research are diverse, though it is important to note that further work must take place to clarify what is possible to achieve in relation to this gene. It is not yet clear how it will be possible to alter sensations of pain and research remains pre-clinical, which means it has yet to be applied to human subjects. As yet, no connection has been made between this discovery and the possible applications to sport. Indeed, no scientist researching this gene is likely to envisage it being used in any sporting context. Yet, some applications of related research have taken place, which provide a useful way of understanding how DREAM might be addressed in sport. For example, for many years athletes have used medical technology, such as ultrasound, to promote the repair of muscle tissue. More recently, this has been considered possible on a genetic level by using various growth factors to promote the repair of damaged tissue (Lamsam, et al., 1997).

Repair versus Enhancement: An Ethical Distinction

When discussing the ethics of modifying performance in sport, authorities are very clear on the distinction between therapy and enhancement. However, it is critical to note that the use of the concept 'enhancement' is somewhat misleading. The intention of sporting authorities is not specifically to prohibit technologies that would lead to the existence of super-humans. Rather, 'enhancement' is defined largely as the 'non-therapeutic' use of medicine, which is often the use of a therapeutic medicine by somebody who has not been diagnosed by a qualified physician as requiring the treatment. Thus, it is not necessarily the case that the pro-enhancement position relies on the use of any unusual or untested technology.

Rather, the pro-enhancement position might, less controversially, be challenging the basis of medical prescription. For example, in consideration

of whether a patient requires something like growth hormone – a physician would base the distinction largely on a biomedical concept of health and specifically on the symptoms associated with growth. However, the pro-enhancement position would argue that this biomedical model is not sufficient to determine what is best for the patient and that, for example, other factors, such as the social circumstances of an athlete must also be taken into account. Thus, even if it is not biomedically necessary for an athlete to receive supplements of growth hormone, she might argue that her career would benefit significantly by the use of such medication, say, by ensuring that she will be taller than she otherwise would be to aid her as a basketball player. By making such a case the athlete would be arguing that the biomedical articulation of health is not sufficient, and that physician's concern for health should also encompass the specific circumstances of somebody's life. Indeed, this argument is often made in sport and sports physicians regularly make a decision of this kind when treating an athlete. Something as simple as muscular spray that permits an athlete to continue training through a muscle cramp is a form of applying a medical treatment for the purpose of permitting the athlete to continue performing through injury.

The broader context of this debate concerns the proper role of medicine in sport. Discussions of this kind arise frequently in relation to cosmetic surgery. In this case, there is a generally accepted norm in some countries that, if surgery is used to correct some deformity that the individual finds difficult to live with, then surgery should be made freely available to the patient. Conversely, if the surgery is used to correct what some would describe as 'trivial' deformities, then society does not have a responsibility to correct that deformity. In the latter case, any surgery to correct the deformity would have to be paid for by the individual. This is not an easy distinction to make, though Welie (1999) argues that the guiding premise must be individual "integrity" (p.173) rather than the normative distinctions between therapy, enhancement, and the aesthetics. When making a broader claim about the limits of medicine, Welie (1999) even refers to athletic enhancements to make the point.

In sum, when discussing the ethical distinction between therapy and enhancement (or, more accurately, non-therapy), it is important to note that the pro-enhancement position is not necessarily about radically augmenting humans to create grotesque beings that are unrecognisable as humans. Moreover, the anti-doping rejection of enhancement is more accurately an assertion of a particular view of health, which follows a biomedical rather

than biocultural model. Thus, it gives less importance to the cultural basis on which a patient might claim their desire for medical intervention.

Because of this biomedical model, it is probable that all anti-doping sporting organisations, such as the World Anti-Doping Agency and the International Olympic Committee, would condemn the manipulation of *DREAM* for sport, since it would be seen as dangerous and unnecessary. Some evidence of this can be found in the recent statements by both of these institutions about the use of genetic technology in sport (WADA, 2002; IOC, 2001). Such a position would reflect the dominant ethical stance in relation to medical technologies and, coupled with the need to apply policy into a context where norms and rules applicable to all are seen as necessary, sport policy on performance demands taking the view that an individualised approach to the ethics of modifying performance is not possible.ⁱⁱ

Yet, *DREAM* (and genetic modification more broadly) challenges the credibility of this distinction. It is not clear whether the modification of *DREAM* would be seen as therapeutic or non-therapeutic. More precisely, it is not clear when a physician would feel justified in utilising this technology for the benefit of a patient. If we consider its use outside of sport for a moment, it is also unclear, though there would almost certainly be a motivation to utilise the technology in pain management, which is widely recognised as a significant problem for patients. The current understanding of pain is such that the methods of pain management come with a number of burdens and obstacles. Consequently, the prospect of a more effective method would be highly desirable. Yet, it begs the question as to what kinds of pain would justify the use of a given form of treatment. Indeed, it also requires understanding precisely what kind of pain should be treated by medicine or described as a health-deficit. One imagines the classic case of the patient who visits his physician seeking a remedy for his broken heart. Coming to a conclusion about this requires understanding more about the nature of pain in sport. The next section of this paper aims to inform that debate, to understand whether there can be a medical justification for wanting to lessen sensations of pain when competing at elite levels in sport.

Which Pains Matter?

The question concerning *DREAM* requires us to ask whether there are some applications where treatment might not be appropriate. In our case,

the question is whether sporting pains deserve medical treatment and, subsequently, whether this is a good reason to legalise DREAM manipulation as a method of altering performance. The idea that some pains are more worthy of treatment than others is highly contested. Perhaps one of the most controversial recent discussions has been in relation to how health care is utilised by smokers who, some argue, voluntarily induce their illness and, on this basis, should be not given treatment. Less radically, this argument often forms part of the decision-making process when having to make difficult moral decisions about the provision of care when resources are scarce or where a reasonable decision is made based upon the likely effectiveness of the treatment. Thus, if a physician has reason to believe that a patient will not benefit from a treatment, because they will most likely resort to behaviour that will make the treatment ineffective, such as through continuing to smoke, then this is regarded as less worthy a case than a patient who is likely to benefit from a treatment in their subsequent behaviour. A comparable example can be found in sports, particularly in relation to extreme sports, where individuals take risks and often rely on a state-funded rescue service to assist them when in trouble. However, the debate about enhancement is not merely a matter of allocating resources and, in sport, this concern is unlikely to be a priority, given that performance technology would not derive from public health care funds (although the care for long-term consequences of, say, drug use in sport, might be a basis for re-visiting this argument).

Understanding what kind of pain deserves treatment requires first understanding what counts as a legitimate instance of pain and why it calls for attention from medicine. Defining pain has been central to a number of ethical and sociological discussions about the role of medicine, though an answer to the rather straightforward question 'what is pain?' remains contested. One of the key points of contention has to do with what counts as an experience of pain. The importance of answering this question has frequently provoked a reference to the foetus and its capacity (or lack of) to experience pain. It is suggested that the experience of pain reveals something about our moral and legal obligations to that life or, more specifically, to seek the alleviation of pain experienced by that life. Thus, if a life is capable of feeling pain, then we have an obligation to minimise that pain and/or ensure that we do not contribute to the experience of any unnecessary pain. An obvious implication of how we describe the foetus example is in relation to abortion. On one view, one might argue that the

pro-life campaign would gain credibility, if it can show that foetuses experience pain at a very early stage in their lives in a similar way to how a fully developed person feels pain.ⁱⁱⁱ Thus, the experience of pain is a measure to which a sense of moral responsibility must adhere.

A genetic world-view has become central to how these problems are addressed, which is particularly pertinent to the analysis of *DREAM*. The ability to perceive genes through medical technology provides a way of making genes meaningful to people. Increasingly, a scientific view of pain dominates and assumes that, for example, if a foetus displays specific chemical reactions, then it is agitated or, potentially, in pain. Yet, the meaning of this demonstration of pain and how it has come to be viewed as 'pain' rather than *nociception* is not obvious. As Benatar and Benatar (2001) explain, nociception is:

“the neural activity in those peripheral receptors and centripetal (that is, afferent) pathways via which noxious stimuli are transmitted to the brain. Put more simply, it is the process whereby noxious stimuli are sensed and transmitted to the brain. Thus, while nociception is neural activity, pain is an unpleasant feeling (p.59).”

In recent years, it has become clear that such a biomedical model of understanding pain is inadequate. Certainly, most people are capable of *feeling* pain in some sense that can be explained biologically, but the ways in which this is expressed and the kinds of circumstances associated with pain differ. For example, Hoffmann (2001) describes how it is possible to identify differences between the way that men and women experience pain. Also, race and ethnicity is suggested to be an important factor in how the articulation of pain is approached by medical practitioners. As Bonham (2001) describes, “People interpret and react to health symptoms, including pain based on their life experiences and their cultural norms” (p.52). This does not mean that, if a man and a woman were each to burn themselves, that they would feel different kinds of pain (though in some circumstances, it does mean this). Rather, people engage with their pain in various ways, which makes us aware that the experience of pain is not just a biological fact, but is also a cultural construct. This point is critical, since the medical profession relies heavily on an individual's capacity to *articulate* their pain, which is itself one instance of how pain is culturally mediated through language. Indeed, the point relates partly to the earlier discussion about the pain experienced by the fetus and

the problems associated with that argument. These discussions inform us of how it would be inadequate to dismiss the importance of pain in sport on the basis of it being self-induced. *Prima facie*, the removal of pain in sport would reduce suffering and would, thus, appear to be medically justified in the same way that other pain-management treatments are justified.

The (Ir)relevance of Pain in Sport

In the context of sport, Elaine Scarry's 'The Body in Pain' (1985) is a useful, if unlikely, place to begin discussing the ethics of DREAM manipulation from a sports ethical perspective. In short, the question that remains to be answered is whether there is any basis on which we can justify the circumvention of pain experiences in sport, or whether the experience of pain plays some important role in what makes sport valuable. Scarry offers an explanation for why injuring others has a special status as a means of distinguishing between opponents in contests. Scarry contrasts the use of injury in 'war' with other possible ways of settling contests, particularly sporting contests. She sets up the question by asking 'What Differentiates Injuring from Other Acts or Attributes Upon Which a Contest Can be Based' (p.91). Scarry then argues that injurious acts are different, just because other kinds of acts are *externally irrelevant* to the nature of a particular contest. To explain this argument, the example Scarry gives is, again, war. She argues that war could not be settled on the basis of a sports contest, such as a tennis or chess match, even if rival countries agreed upon the rules. This is because 'sports' are not relevant to the nature of the dispute. In other words, the test of a sport is not relevant to political disputes. In contrast, if the test were to decide who had the sharpest mind, then a chess match might be appropriate (and a war would not). However, it is unlikely that, for example, a test to see who could drink the most alcohol would, in this case, be relevant.

Scarry's argument informs us that the act of injury is *not* a relevant aspect of a contest in the majority of circumstances. Thus, the basis upon which political disagreements should be settled has nothing to do with violence or war. Therefore, to enter into injurious acts as a basis for resolving such disputes, actually fails to grasp the notion that what lies at the heart of the dispute is not a violent issue, but a matter of contested discourses. In this sense, war is a desperate attempt at trying to make oneself heard, when one's arguments are not met with sympathy. Scarry

claims that sports contests would not be useful to settle political disputes, since parties could always break the rules of the sport to gain an advantage or claim that they were cheated by opponents, thus giving them reason to reject the contest's outcome. If the dispute is settled by war – where there are, theoretically, no rules – then competitors could not resort to other tactics to gain an advantage, since there is an assumption that opponents already employ any such means.^{iv}

In this context, what gives sport value does not derive from the infliction of pain on the opponent or, more specifically, the achievement of athletes is not measured in their capacity to withstand pain during their performance. Even in blood sports, the importance of pain is secondary to the demonstration of skill. Contests are not won by demonstrating the greatest capacity to withstand pain. In this sense, pain is irrelevant to sporting performances and is not an indication of sporting prowess. On this basis, it would be desirable to find ways of equalising pain sensations in sport.

The Symbolic Value of Sporting Pains

This view might appear to conflict with Safai's (2003) claims about the role of pain in sport: "pain tolerance become physical and symbolic markers of character for many athletes" (p.129). On Safai's view, being in pain is 'normal' in sport and sports are unavoidably violent. Pain is a vehicle for knowing that one is working hard and trying, and by embodying those values we (and athletes) believe are important for athletes to exhibit. The phrase 'No pain, no gain' derives out of circumstances where this means something to athletes. Yet, these findings do not constitute a medical endorsement of these circumstances, which is the central position that must be addressed. Moreover, neither is it clear whether this kind of pain is the kind that is under critique. Thus, we would wish to distinguish between the pain felt by performing through, say, a sprained wrist or dislocated shoulder and that which is felt in the legs during the final mile of a marathon. One would suspect that it is the latter of these that is described in Safai's findings. Yet, for either case, my position remains that, despite this endorsement of pain experiences within sporting ethos, the value of sport does not derive from this ethos. Indeed, Safai offers some criticisms about this pain discourse in sport:

“Pain and injury tolerance in sport warrants in-depth investigation not only because of the social processes that normalise pain and injury in sport, but also because of the damaging, potentially devastating, consequences to the health and well-being of many people. Pain and injury occur in an environment that is often cloaked in uncritical and unquestioned acceptance and idealisation (p.127).”

The concerns about the way athletes value pain reinforces the uncertainty about how DREAM manipulation might be evaluated or used. Arguably, the fact that athletes would appear to value pain tolerance as a symbolic characteristic of athletic superiority seems desirable to undermine. After all, it would be difficult for the medical profession to endorse a discourse that legitimises such sentiments. Yet, because of this possible resistance from athletes, it is very difficult to conclude the ethical status of such technology. Thus, where one might find it easier to argue that the enhancement-seeking athlete recognises their chosen pursuit as constitutively technological (and even trans-human), the possible resistance to DREAM manipulation would suggest otherwise. In short, it would appear that the high-tech athlete would not seek to utilise this technology for performance, because it would undermine something presumed to be of value to sport. Safai’s research suggests that its use would be resisted and this disrupts the idea that athletes (cheating or not) are engaged in a pursuit of trying to undermine biology by using technology.

Specifically, it is not possible to assume that athletes would desire the use of genetic technology to circumvent pain or, at least, that there are competing views on the value of performance that would emerge with the prospect of DREAM manipulation. The first would entail the desire to minimise pain sensations so as to optimise sporting capacity. The second would seek to ensure a performance is not seen as any less valuable because it did not require as much suffering as it would without the pain management technology.

A Worthwhile DREAM?

The purpose of this inquiry has been to recognise the conceptual overlap between therapy and enhancement when considering the utilization of emerging, preventive medicine, such as genetically driven pain

management. Understanding the complexity of the distinction between therapy and enhancement requires taking to task the ethical assumptions about each. This is why the discussion has focused mainly on the ethical status of therapeutic technology in sport. While it can be argued that the capacity to endure pain in sport is medically unconscionable, its tolerance has a symbolic and functional status that challenges the idea that athletes would willingly use this technology to enhance their performance. Such use would be conceptually different from, say, using hormone therapy to build muscle mass. On this basis, whereas it has been commonplace for anti-doping rhetoric to condemn enhancement and embrace therapeutic medicine, this distinction underestimates the complexity of both terms and the inadequacy of basing an ethical distinction on their assumed characteristics.

DREAM manipulation problematises what constitutes an ethical performance in sport. It brings into question what values underpin sport and the medical principles on which anti-doping codes have been based, which lead to making such distinctions as that made between therapy and enhancement. Moreover, it raises the question about what sporting authorities are trying to protect when they base arguments against doping on the well-being of athletes. Importantly, the value of this distinction is asserted largely from the medical side of sport. Sport has a legitimate interest in performance enhancement and it is widely understood that the only obstacle to athletes using any biochemical method of performance enhancements is the ethical permissibility of the technology. It has been argued here that pain tolerance does not contribute to establishing who is the better athlete and, for this reason, technology that can equalise this human characteristic would be a desirable innovation for competition.

References

- Barendse, M. A. (1983) 'Individualism, Technology and Sport: The Speedway Nexus', *Journal of Sport & Social Issues*, 7, 1: 15-23.
- Benatar, D. and M. Benatar. (2001) 'A Pain in the Fetus: Toward Ending Confusion About Fetal Pain', *Bioethics*, 15, 1: 1-31.
- Bonham, V. L. (2001) 'Race, Ethnicity, and Pain Treatment: Striving to understand the causes and solutions to the disparities in pain treatment', *Journal of Law, Medicine & Ethics*, 29: 52-68.
- Bostrom, N., (1998) What is Transhumanism?,
<http://www.nickbostrom.com/old/transhumanism.html>
- Breivik, G. (1998) Limits to growth in elite sport: Some ethical considerations. 20th World Congress of Philosophy, Boston. Available online:
<http://www.bu.edu/wcp/Papers/Spor/SporBrei.htm>
- Butryn, T. (2002) 'Cyborg Horizons: Sport and the Ethics of Self-Technologization', in A. Miah and S. B. Eassom. *Sport Technology: History, Philosophy and Policy*. Oxford, Elsevier Science: 111-133.
- Butryn, T. M. and M. A. Masucci. (2003a) 'It's not about the book: A Cyborg counternarrative of Lance Armstrong', *Journal of Sport and Social Issues*.
- Butryn, T. M. (2003b) 'Posthuman Podiums: Cyborg Narratives of Elite Track and Field Athletes', *Sociology of Sport Journal*.
- Cheng et al. (January 11, 2002). DREAM is a critical transcriptional repressor for pain modulation. *Cell*, vol. 108, p. 31-43.
- Cheng, H.-Y. M. and J. M. Penninger. (2003) 'When the DREAM is gone: from basic science to future prospectives in pain management and beyond', *Expert Opinion on Therapeutic Targets*, 7, 2: 249-263.
- Cole, C. (1994) 'Hybrid Athletes, Monstrous Addicts and Cyborg Natures', *Journal of Sport History*, 21, 2: 228-239.
- Davidson, J. (1985) 'Sport and modern technology: the rise of skateboarding', *Journal of Popular Culture*, 18, 4: 145-147.
- d'Agincourt-Canning, L. (2001) 'Experiences of Genetic Risk: Disclosure and the Gendering of Responsibility', *Bioethics*, 15, 3: 231-247.
- Derbyshire, S. W. G. (1999) 'Locating the Beginnings of Pain', *Bioethics*, 13, 1: 1-26.
- Derbyshire, S. W. G. (2001) 'Fetal Pain: An Infantile Debate', *Bioethics*, 15, 1: 77-84.
- Delgado, R. (2002) 'Forget exercise, pop a fitness pill', *Chronicle*.

Fukuyama, F. (2002) *Our Posthuman Future: Consequences of the Biotechnology Revolution*, London: Profile Books.

Gelberg, J. N. (1995) 'The Lethal Weapon: How the Plastic Football Helmet Transformed the Game of Football, 1939-1994', *Bulletin of Science, Technology, and Society*, 15, 5-6: 302-309.

Gelberg, J. N. (1996) 'The Rise and Fall of the Polara Asymmetric Golf Ball: No Hook, No Slice, No Dice', *Technology in Society*, 18, 1: 93-110.

Gelberg, J. N. (1998) 'Tradition, Talent and Technology: The Ambiguous Relationship between Sports and Innovation', in A. Busch. *Design for Sport*. London, Thames and Hudson: 88-110.

Gibson, J. H. (1993) *Performance vs Results: A Critique of Values in Contemporary Sport*, Albany: State University of New York Press.

Gray, C. H., S. Mentor, et al., Eds. (1995) *The Cyborg Handbook*. London: Routledge.

Gray, C. H. (2002) *Cyborg Citizen: Politics in the Posthuman Age*, London: Routledge.

Have, H. A. M. J. t. (2001) 'Genetics and Culture: The geneticization thesis', *Medicine, Health Care and Philosophy*, 4: 295-304.

Hayles, N. K. (1999) *How we became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*, London: University of Chicago Press.

Hoberman, J. M. (1992) *Mortal Engines: The Science of Performance and the Dehumanization of Sport*. New York: The Free Press (reprinted 2001, The Blackburn Press).

Hoffmann, D. E. and A. J. Tarzian. (2001) 'The Girl who Cried Pain: A Bias Against Women in the Treatment of Pain', *Journal of Law, Medicine & Ethics*, 29: 13-27.

Hubbard, R. (2003) 'Science, Power, Gender: How DNA Became the Book of Life', *Signs: Journal of Women in Culture and Society*, 28, 3: 791-799.

Hummel, R. L. and G. S. Foster. (1986) 'A Sporting Chance: Relationships Between Technological Change & Concepts of Fair Play in Fishing', *Journal of Leisure Research*, 18, 1: 40-52.

Illich, I. (1976/1990) *Limits to Medicine: Medical Nemesis: the Expropriation of Health*, London: Penguin.

International Olympic Committee, (2001) Press Release: IOC Gene Therapy Working Group - Conclusion. Lausanne, International Olympic Committee:
http://www.olympic.org/uk/news/publications/press_uk.asp?release=179.

Fukuyama, F. (2002) *Our Posthuman Future: Consequences of the Biotechnology Revolution*, London: Profile Books.

Lamsam, C., F. H. Fu, et al. (1997) 'Gene Therapy in Sports Medicine', *Sports Medicine*, 25, 2: 73-77.

- Lewis, B. E. (2003) Prozac and the Post-human Politics of Cyborgs, *Journal of Medical Humanities*, 24, 1/2: 49-63.
- Lippman, A. (1992) 'Led (Astray) by Genetic Maps: The Cartography of the Human Genome and Health Care', *Social Science and Medicine*, 35, 12: 1469-76.
- Loland, S., (1998) The Record Dilemma, 20th World Congress of Philosophy:
<http://www.bu.edu/wcp/Papers/Spor/SporLola.htm>.
- McCrory, P. (2001) 'Ethics, molecular biology, and sports medicine', *British Journal of Sports Medicine*, 35, 3: 142-143.
- Melzer, D. and R. Zimmern (2002) 'Genetics and Medicalisation: Genetics could drive a new wave of medicalisation if genetic tests are accepted without appropriate clinical evaluation', *British Medical Journal*, 324: 863-864.
- Miah, A. (2004) *Genetically Modified Athletes: Biomedical Ethics, Gene Doping and Sport*. London and New York: Routledge.
- Miller, P. S. (1998) 'Genetic discrimination in the workplace', *Journal of Law, Medicine & Ethics*, 26, 3: 189.
- Moynihhan, R. and R. Smith. (2002) 'Too much medicine?: Almost Certainly', *British Medical Journal*, 324: 859-860.
- Munthe, C. (2000) 'Selected Champions: Making Winners in an Age of Genetic Technology', in T. Tännsjö and C. Tamburrini. *Values in Sport: Elitism, Nationalism, Gender Equality, and the Scientific Manufacture of Winners*. London and New York, E & F.N. Spon: 217-231.
- Rintala, J. (1995) 'Sport and Technology: Human Questions in a World of Machines', *Journal of Sport and Social Issues*, Feb: 63-75.
- Rosner, M. and T. R. Johnson. (1995) 'Telling Stories: Metaphors of the Human Genome Project', *Hypatia*, 10, 4: 104-129.
- Safai, P. (2003) 'Healing the Body in the 'Culture of Risk': Examining the Negotiation of Treatment Between Sport Medicine Clinicians and Injured Athletes in Canadian Intercollegiate Sport', *Sociology of Sport Journal*, 20: 127-146.
- Scarry, E. (1985) *The Body in Pain: The Making and Unmaking of the World*, Oxford: Oxford University Press.
- Shogan, D. (1999) *The Making of High Performance Athletes: Discipline, Diversity and Ethics*, Toronto: University of Toronto Press.
- Shogan, D. (2002) 'Disciplinary Technologies of Sport Performance', in A. Miah and S. B. Eassom. *Sport Technology: History, Philosophy and Policy*. Oxford, Elsevier: 93-109.
- St Louis, B. (2003) 'Sport, Genetics and the 'Natural Athlete': The Resurgence of Racial Science', *Body and Society*, 9, 2: 75-95.

Tamburrini, C. M. (2002) 'After Doping What? The Morality of the Genetic Engineering of Athletes', in A. Miah and S. B. Eassom. Sport Technology: History, Philosophy and Policy. Oxford, Elsevier Science: 253-268.

Thacker, E. (2002) Bio-X: Removing bodily contingency in regenerative medicine. Journal Medical Humanitiesof proxy4.pdf in desktop articles folder.

World Anti-Doping Agency, (2002) Press Release: WADA Conference Sheds Light on the Potential of Gene Doping. New York, World Anti-Doping Agency: <http://www.wada-ama.org>.

Welie, J. V. M. (1999) "Do you have a healthy smile?", Medicine, Health Care and Philosophy, 2, 2: 169-180.

Acknowledgement

Thanks to my dear friend and colleague Parissa Safai, University of Toronto, for her critical insights on this topic and for bringing DREAM to my attention

ⁱ Specifically, at least two other researchers seemed important in the process of this historic finding, Rosalind Franklin and Maurice Wilkins.

ⁱⁱ However, if one looks to other kinds of enhancements, there is some evidence to support an individualised perspective on what is ethical. For example, in many sports there is considerable flexibility on what kind of equipment an athlete is allowed to use, even if the equipment must fall within some minimal parameters.

ⁱⁱⁱ Though it is interesting that the burden of proof appears to rest with demonstrating that foetuses do experience pain, rather than being able to demonstrate that they do not, despite the relative strength of each position.

^{iv} This omits a significant discourse on the art of war, as well as saying very little about some means that are not used by opponent for various reasons. Biological weapons and weapons of mass destruction are examples of such means that are part of these unwritten rules of war and their instable status is the basis of many ethical discussions about agreements on nuclear weapons and so on. Regardless of these arguments, Scarry implies that war is supposed to entail a 'win at all costs' approach, where any means are legitimate. This is qualitatively different from the 'win at all costs' approach in sport, athletes accept only the use of specific means and where far greater rules exist on what is acceptable.