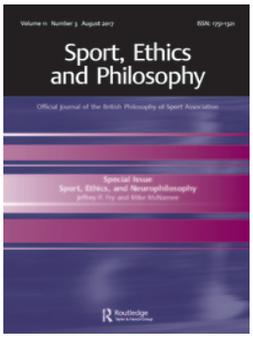

Sport, Ethics and Philosophy

ISSN: 1751-1321 (Print) 1751-133X (Online) Journal homepage: http://www.tandfonline.com/loi/rsep20

On the Compatibility of Brain Enhancement and the Internal Values of Sport

Alberto Carrio Sampedro & José Luis Pérez Triviño

To cite this article: Alberto Carrio Sampedro & José Luis Pérez Triviño (2017) On the Compatibility of Brain Enhancement and the Internal Values of Sport, Sport, Ethics and Philosophy, 11:3, 307-322, DOI: 10.1080/17511321.2017.1320687

To link to this article: http://dx.doi.org/10.1080/17511321.2017.1320687

Published online: 26 May 2017.

SPORT, ETHICS AND PHILOSOPHY, 2017
VOL. 11, NO. 3, 307–322
https://doi.org/10.1080/17511321.2017.1320687

Routledge
Taylor & Francis Group

On the Compatibility of Brain Enhancement and the Internal Values of Sport

Alberto Carrio Sampedro and José Luis Pérez Triviño

Philosophy of Law, Pompeu Fabra University, Barcelona, Spain

ABSTRACT
Elite athletes are characterized by their high level of performance in sport. Since the very beginnings of sport, it has been understood that physical and physiological abilities influence the performance of athletes. Advances in scientific knowledge, especially sport psychology and neuroscience, seem to confirm this intuition and consequently it is possible to characterize elite athletes as having an extraordinary combination of physical and mental abilities. Techniques and substances that contribute to enhancing physical characteristics of athletes have also been well known for ages. But it is now possible to make use of other techniques and substances that not only enhance physical abilities but also cognitive capabilities, which seem to require greater consideration given their direct impact on the athlete's brain. In this article, we examine two such techniques, cognitive enhancers and transcranial stimulators, and highlight the potential advantages and drawbacks that applying each one may have on sport. Given the relative novelty of these enhancement techniques and substances and the absence of conclusive evidence regarding their short- and long-term effects, we deem that their use ought to be strictly governed by cautionary principles. But due to that same lack of evidence, we believe that the possibility of examining the feasibility of applying these techniques to sport should not be denied.

KEYWORDS
Sport performance; cognitive enhancement; neuroenhancers; transcranial stimulators; neurodoping; theory of sport

1. Introduction

According to Hoberman, performance in sport can be defined as all the psychological or physiological efforts that can be quantified or assessed in physical or psychological terms (Hoberman 64). Without a doubt, the effort put in by elite athletes and their level of control in strenuous situations exemplify the epitome of sport performance. This almost inhuman psychological and physiological performance ability embodies, to use McNamee's ideas, the genuine ideal of the athlete.[1] It can be said, therefore, that the performance of elite athletes is the result of an extraordinary confluence of physical and psychological abilities. We admire athletes not only for their physical strength, their extraordinary ability to push through their limits, their self-confidence and their ability to adapt to unpredictable situations, but also for their *psychological* orientation towards success. All of these abilities are defining characteristics of what has been call the 'athletic identity' (AI).[2]

CONTACT Alberto Carrio Sampedro alberto.carrio@upf.edu

In this article, we assume that cognitive abilities play a decisive role in sport performance, and that, as a result, it is important to analyse the impact and viability of new cognitive enhancement techniques such as neuroenhancers and transcranial stimulators as applied to athlete performance. Thus, to provide a roadmap for this article, in Section 2, we analyse the relationship among athletic identity (AI), training and technological enhancements applied to sport. Next, in Section 3, we provide a general overview of cognitive enhancement in sport. In Section 4, we deal with neuroenhancers and in (5) we turn to transcranial stimulators. In Section 6, we analyse some of the objections and normative problems related to the use of these techniques in sport. We will then propose an interpretation that makes the restricted use of these techniques compatible with the internal values of sport.

2. The athletic personality and technological, physical and psychological enhancements

Physical abilities are a decisive factor in sport. When thinking of athletes training, it is likely that the first image that comes to mind is, as we have already mentioned, the great physical effort made when they follow strict training regimes. Certainly athletes, and especially elite athletes, go above and beyond the limits of healthy physical exercise as recommended by the World Health Organization (WHO).[3] Consider, for example, that in accordance with the 'Nomenclature for performance achievement levels' (NPAL), athletes who are Olympic gold medal winners or world champions are classified as 'super elite' while those who finish in second place are characterized as 'elite'.[4] There is little doubt that any of the athletes who fit into these categories possess quite a rare combination of physical and psychological traits. One of the first things that all athletes learn at the very beginning of their careers is that winning requires hard work and the demonstrated ability to suffer through and adapt to inherently adverse circumstances in all competitive situations. There are certainly many restrictions that an athlete's life is subject to: rigorous training sessions, strict diets, injuries and concentration on the desired goal. The attitude and action of overcoming these obstacles is called 'resilience'.[5] In the sport world, 'resilience' can be defined as a dynamic psychosocial process which at the same time (i) implies interacting with others and reinforcing the values of mutual support and friendship, particularly in team sports and (ii) is temporary and factually dependent, given that it varies depending on the competition schedule and factual circumstances, such as injuries.[6] It is obvious that the lifestyle of any of those athletes is not exactly enviable.[7] This is even more obvious given the fact that if the World Anti-Doping Agency requirements for maintaining a 'clean' biological passport are taken into account, athletes are in fact pressured to place the demands of their profession over taking care of their own health.

To meet these demands, athletes tend to resort to applying technology to their training, a trend that has been growing in recent years. The elaborate design of modern athletic apparel and shoes, the machines that allow athletes to build up strength and endurance, the wind tunnels used to rehearse body techniques to reduce air resistance, and many other innovations are simply the most well-known examples.

But physical performance cannot be equated with raw performance. To produce best results, physical performance must be accompanied by strict concentration and training for competition. Said another way, the effort needed to take full advantage of an athlete's

maximum potential must be rationalized. Thus, this is where AI plays an essential role.[8] Let us examine this concept in greater detail.

Athletes can be defined by the degree with which they identify with their activity.[9] In this way, those who possess a strong Athletic Identity are more willing to submit themselves to the restrictions required by the practice of the sport. That is to say those who possess this strong athletic personality are better psychologically prepared to deal with the rigours of competition. As we will see further on, this characteristic is essential to success in highly competitive sport.[10]

Thus, if AI lays the groundwork for the psychological motivation of the athlete, the ends seems to be as important as the means employed to attain it. This raises the question of whether the ends and means are completely incompatible, or if, on the contrary, to what extent they are compatible.

The incompatibility thesis can be defended from different perspectives. But once the importance of the ends is conceded—to increase the level of motivation of the athlete, scientific and technological advances to improve athlete motivation offer great opportunity. As we have just seen, this is what occurs with preparation and physical performance thanks to the scientific and technological advances that enhance muscle endurance or increase aerodynamics. At the end of the day, all these means are human artefacts that fall into the category of technology in sport.[11] Thus, since 'technology is a necessary condition for many sports to arise at all'[12]; the question is which technology should be permissible to use in sport to attain the very goals of sport?

Another perspective of incompatibility is the one that highlights that cognitive enhancement techniques put the continuity of internal values of sport at stake and they consequently distort the nature of the practice.[13] The question that follows is why we must be more averse to the scientific advances applied to enhancing athletes' brains (and their cognitive functions), than to other kinds of enhancement. Such is the case of physical enhancement with all the nuances that have emerged in discussions of doping.[14]

The compatibility thesis is not blind to the implications of cognitive enhancers in sport. It only points out that there is little doubt that once the physiology of the brain is known and the areas that influence motivation and other cognitive abilities that affect athlete performance have been mapped,[15] it is possible to stimulate them to enhance that performance. The issue to which we alluded earlier, is which of these theses offers a more promising perspective on sport and, in any case, to what extent these means are compatible with the ends and goals of sport.

The repercussions that psychological abilities have on sport performance have been well known for quite some time (Hoberman). Among these abilities, it is worthwhile to differentiate between moods—emotional abilities in the broad sense of the term and cognitive abilities. One practical example with regard to the former is the possibility of treating certain emotional states, like depression, extreme shyness or phobias, in order to better the quality of life of those who suffer from these states. It seems obvious that applying these techniques to the sport arena contributes to a better quality of life and improved performance of athletes. This use of psychological techniques would be included in what Loland has called technology which can 'prevent injury and protect against harm'.[16]

Yet another category would better integrate cognitive enhancements in the strict sense of the term, i.e. those which aim to go beyond dealing with the above-mentioned treatment cases and directly affect performance in sport. In other words, according to Loland, they

constitute 'performance-enhancing technology in sport'.[17] The following table provides an overview of the different types of intervention and their possible application to sport.

Abilities:	Therapy	Enhancement
Physical.	1	2
Cognitive.	3	4

As we mentioned above, this article focuses on the fourth case, i.e. on the enhancement of cognitive abilities given that advances in the field of sport psychology have opened up new prospects for their treatment and enhancement. It is for this reason, as we also alluded to above, that we will deal with the impact of two of the techniques currently used in sport psychology on sport enhancement, the so-called cognitive enhancers and cranial stimulators.

But before going on to scrutinize the challenges that these techniques present for sport, perhaps it would be better to make a few basic assumptions explicit.

(1) The physical and psychological abilities of athletes, despite being sine qua non for elite athletes, are not always the determining factor of success. There are cases in which luck plays the key role.[18]
(2) It is necessary to consider that genetic and social factors are involved in the possession and development of these abilities.
(3) The impact of the natural lottery, social status and luck is uneven, depending on the type of competition that is being dealt with.[19]

The analysis to be carried out focuses on the growing interest that the open debate in psychology and neuroscience has sparked in the sport arena with regard to the mind–body duality,[20] but given that it is not possible to deal with such a broad scope of issues, we will restrict our focus to technical and scientific innovations which are liable to be applied to enhancement of sport performance.

3. Cognitive abilities in sport

The zeal to improve performance in sport has been a constant throughout the history of sport. And given that sport performance, as we have just seen, is influenced by both physical and cognitive factors, it is not rash to claim that the interest in improving both has been equal. But it has not been until modern times that sport has felt the reverberations of the incursion of sport psychology as a powerful instrument to improve the performance of athletes:

> The first physiologist discovered that scientific studies must operate at this border where physiology and psychology overlap. (Hoberman 1992, 157)

In the evolution of sport psychology, we see at least two stages. In the first, the fundamental concern was to balance the athlete's emotional states in such a way that performance would be improved. Hoberman confirms that 'the idea of manipulating the mind—a popular concern in our times'—occurs at the beginning of the twentieth century. (Hoberman 1992, 225). The research from abnormal psychology in this area focused on better management of stress, burnout and end-of-career anxiety (Tamorri 2004, 5).

The second stage can be identified by an overall expansion of sport psychology that allowed a glimpse at the potential to optimize mental training and mood, which are highly influential in sport performance.

There are at least two relevant reasons to deal with the impact of cognitive improvement on sport performance and, consequently, the structure of competition. This is because in certain disciplines, the cognitive aspect has special relevance. An extreme example of this is chess, but other sports are not far behind: these others require a high degree of interdependence between competitors to carry out complex strategies, as is the case in most of team sports.

The second reason is more significant. It concerns the link between physical and cognitive abilities on sport performance (Foddy 2011). Even if it is true that physical abilities are those that can be quantified in terms of sport performance, it is not less true, as Bennet Foddy highlights that

> all such variations (physical actions) are mediated, at least in part, by the actor's brain, spinal cord, and peripheral nervous system. Neurological systems play a role in determining how far we throw a javelin, how deeply we breathe while swimming … and how long we can withstand the pain of endurance cycling.

Cognition is understood as the process employed by an organism to organize information, a process which includes the following abilities: (i) acquisition (perception); (ii) selection (attention); (iii) interpretation (understanding) and (iv) retention (memory). In accordance with this, cognitive enhancement can be defined as any increase in information-processing abilities involved in the cognition process by any means or system, internal or external (Sandberg 2011, 71). Given this characterization, it is not difficult to highlight the intimate connection between these abilities and the functions that sportspersons carry out on a daily basis in their athletic workouts. It is, therefore, unsurprising that the interest in cognitive enhancement has done nothing but increase in the sport arena. There are even popular sayings which imply that these abilities are the reason behind winning:

> The difference between winning and losing is 99% psychological.

> 90% of sports is mental and the other half is in the head.

Although these claims may be exaggerated, it is clear that there have been different psychological methods and techniques developed in recent decades that improve sport performance.[21] The advances in sport psychology (LeUnes, 2011, 201), cognitive sciences and neuroscience thus seem to have elements that should be taken into account.

Just consider the spectacular development that has been seen in neuroscience and the importance that its progress has had in promoting more accurate knowledge of brain function. The tools that it offers allow the intuitions of sports psychologists to be explained with a little more clarity, in this way linking motor functioning directly to the brain.[22]

There are even those who argue that advances in neuroscience entail revolutions similar to those which were sparked by Galileo in physics or Darwin in biology. Taking all that into account, sport cannot stand by the wayside in the face of those advances. But rather the opposite is true: it should work together with them as they allow exploring unimaginable possibilities (Tamorri 2004, 10).

Perhaps the main contribution of neuroscience to sport will be the possibility of establishing a greater degree of accuracy of the relationship between brain and motor functions and their eventual enhancement.

This is what is occurring with brain stimulation, whether it be visual, auditory or of the video variety, to locate areas that process information. Once they have been located and their complex functioning is understood, there is nothing to stand in the way of improving it, to the best of our abilities. Tamorri, for example, argues that the structure of a champion can be suitably identified:

> A champion is a blend of muscular reaction and biomechanics, developed through a delicate, fine and complex process of information recovery, decoding and programming that is found in his brain, in his biology, in his neurotransmitters and finally, in his cognitive processes, organic capabilities but also the emotional, cultural and practical ones are the reasons behind one response or another. (Tamorri 2004, 9)

According to this author, neuroscience lends to sport:

> The knowledge of the molecular and neurochemical mechanisms at the base of motor memory and tactical memory, the athlete's ability to adapt to diverse situations by quickly resynchronizing biological rhythms after jet lag or the ability to take advantage of situations such as the release of emotional states like happiness, pain, frustration, enthusiasm, disappointment, or even the plasticity in the process that allows the nervous system after it finishes to form what are likely new synapses that are located throughout a great number of in distinct associative areas at that foundation of learning processes. All of this would justify in any case the meaning of training. (Tamorri 2004, 10)

In addition to the detailed understanding of the complex interaction between biological and emotional processes in the brain, N. Davis has recently suggested that the advances in neuroscience would mean:

> that the skills and abilities underpinning sports performance can be enhanced using technologies that change the activity of the brain. These factors may include motor learning, enhanced muscular strength or reduced fatigue, or even changes to mental state or concentration. (Davis, 649)

Up to now, it seems evident that the knowledge offered by neuroscience on factors intervening in cognitive processes is extremely valuable and can be applied in the sport arena.

This being the case, the question that follows is whether this practice is justified.

We will not rush to give a hurried answer to this question, but rather in what follows we will examine some cognitive enhancement techniques and their application to sport performance.

4. Cognitive enhancers

Related to the advances which have just been mentioned, pharmaceutical laboratories have recently developed a variety of substances which can improve cognitive abilities, the so-called cognitive enhancers. These cognitive enhancers were initially designed to treat neurodegenerative diseases that arise in the aging process. But these products are also effective at improving cognitive abilities of healthy individuals. The advantages that these cognitive enhances offer are, among others, increased wakefulness and the ability to maintain high levels of attention and concentration under stressful mental conditions as well as the improvement of memory (Eronia 2012, 7). But there are also those who question their effectiveness:

> Many authors who are interested in direct brain intervention are happy to confidently assert that methylphenidate and modafinil are effective cognitive enhancers. Even when authors do not explicitly state that stimulants improve cognition, they frequently appear to assume that they

> do. However, the evidence that either drug might provide any useful form of cognitive enhancement is scant […] Even the positive finding about improvement of memory is a little difficult to translate into a real world scenario. The type of statistical analysis used was chosen because it allowed markedly different studies to be drawn together, however, the various methods used to assess memory differed markedly from study to study. (Dubljević and Ryan 2015, 26–27)

It is likely that the most well-known cognitive enhancing substances are methylphenidate (Ritalin[23]) and modafinil (Provigil); among their various effects are stronger memory and concentration abilities. Thus, they have been classified as cognitive enhancing substances (Dubljević and Ryan, 2015, 25).

The former blocks the re-uptake of dopamine, a neurotransmitter in the synapses. It can also increase the release of dopamine and noradrenalin (norepinephrine). While the connection between methylphenidate and cognitive enhancement may take place in a variety of ways, it is currently not known how the actual mechanism used by this drug works. Methylphenidate is associated with a series of adverse side effects including nervousness, drowsiness and insomnia as well as being contraindicated during pregnancy (Dubljević and Ryan, 2015, 26).

In contrast, modafinil involves short-term risks; however, its relatively recent appearance on the market prevents the long-term effects from being evaluated at this time. Despite being a weak dopamine reuptake inhibitor, modafinil's concentration after being taken orally is high enough to substantially affect dopamine reuptake, which could explain the rare in-stances of psychosis and mania related to its use.

The first trials with these substances were carried out with airline pilots and soldiers given that these drugs allowed them to improve their concentration and withstand fatigue. But with time their use has spread. Currently, it is calculated that between 5 and 15% of students in the United States have taken one of these substances with the goal of improving their academic performance. In any case, it is not just students who have tried these substances but also executives at many companies have used them with a view to mitigating fatigue, alleviating concentration deficits and avoiding burnout. Little time was needed to prove the impact that these drugs can have on special subjects, particularly those that suffer from ADHD.[24]

It was unavoidable that these substances would also impact sport. Inasmuch as they act on neurotransmitters, they improve the transmission of information and optimize physiological performance. For certain sports, these abilities are quite important and can even decisively increase sport performance; consider, for example, the effects of improvement in attention for a javelin thrower, a golfer or an archer. Nonetheless, there is insufficient research to support the claim that selective androgen receptor modulators, antiestrogens, are in fact performance enhancing. In other words, there is little data to back up their effectiveness for such a purpose.[25] In any case, there are legitimate uses of these kinds of drugs. For example, although Major League Baseball banned amphetamines in 2006, there has been a dramatic rise in the number of therapeutic use exemptions issued to players for attention-deficit disorder diagnoses, for which drugs like Ritalin and Adderall can be legitimately prescribed. In 2006, 28 players applied for the exemption, while a year later there were 103. There is growing suspicion that many of these ADD diagnoses are just excuses to get the pills.[26]

Still, scientific warnings about possible undesirable side effects, such as dependence, cannot be ignored. In all likelihood, it is for this reason that they have been included on WADA's banned listed, just as other stimulants are[27]; this is also the case for amphetamines

and cocaine and was the case for caffeine in the past. At the end of the day, in all of these cases the availability of neurotransmitters in the brain is increased, inciting them to function more quickly.[28]

But in addition to these substances, there are also certain neurotechniques which are capable of improving brain functioning. There are three main types of physiological interventions on the brain (Merkel et al. 2007, 119): genetic, electromagnetic and surgical. This last one can be further differentiated into its different techniques: (a) implants or neuroprosthetics, including computer (bionic) interfaces, (b) intracranial insertion or implantation of cells to repair tissues, or cells that administer certain bioactive compounds to certain areas and (c) intracranial gene transfer techniques for heightening or diminishing the action of healing proteins.

While all of these techniques raise important issues to sport philosophy and ethics, given the limited scope/length of this article, in the following section, we will focus exclusively on electromagnetic techniques on the brain.

5. Brain stimulation techniques

In spite of the initial scepticism with which brain stimulation techniques were initially met, they have gained rather widespread acceptance in the field of sports (Goodall 2012, 7), and recent advances in neuroscience suggest that the abilities and capacities which underpin sport performance can be enhanced thanks to the use of technology that modifies brain activity. These factors may include motor learning, improved muscle strength, reduction in fatigue or even changes in mental state or concentration. As Davis puts it:

> modulating the activity of the brain during training or during sport will lead to benefits comparable to those of using drugs. The devices needed to generate these effects are already available, and are currently in use in laboratories or clinics to produce short- or long-term changes in performance. (Davis 2013, 649)

Another possible advantage to using brain stimulation is that the risks associated are relatively low as long as the technique is not abused. However, it is true that the information needed to set limits on brain stimulation or to know the long-term effects that it may have on athletes is in fact currently lacking.

The main brain stimulation techniques that are currently available are as follows:

(1) Transcranial magnetic stimulation (TMS) provokes the depolarization or hyperpolarization of neurons in the brain. TMS utilizes electromagnetic induction to induce weak electric currents in a rapidly changing magnetic field. Thus, certain activity is generated in specific or general parts of the brain, allowing brain functioning as well as the interconnections established within it to be studied. These effects take place in the stimulation phase for several dozen minutes and make the long-term reorganization of brain activity possible if stimulation is applied at regular intervals (Davis 2013, 649–650).

(2) Transcranial current brain stimulation (TCS) is a technique within which two variants can be distinguished; however, here we will focus on transcranial direct current brain stimulation (tDCS), which is characterized by a neural stimulation method that utilizes a constant low current, directly applied via small electrodes to the area of interest in the brain. The magnetic field's magnitude and polarity on the brain's

> surface close to the electrodes determines its effect: the cells in the anode area increase in excitability through this process which involves modulating the resting cellular membrane potential. Initially developed as a therapy for patients with brain injuries, it has been shown to increase cognitive abilities in different ways depending on which part of the brain is stimulated (Kanai et al. 2008, 1839).

According to Davis, the most notable difference between the two techniques is that the former focuses on connected areas of the brain while the latter's effects are spread across the whole brain. Nevertheless, TCS offers the advantage of being more affordable and more portable. In fact, wireless TCS stimulators are already commercially available and there are websites that give instructions for home-made varieties of this device.

For this reason, Davis argues that brain stimulation will become the key technology in the future of sport and of sport medicine. There are two effects, according to this author, that neurodoping will have on sport performance. The first has to do with temporary performance. For a 20- to 60-min period following treatment, there was improved response time and time-to-fatigue as well as suppression of tremor. After a period of time, the effects declined but the usefulness this technique may have on athletic competition is irrefutable; take, for example, the usefulness of their effects on tests of speed or jumping.

The second use of this neuroenhancement is in the acquisition of skills:

> Skills learned in the context of anodal tDCS are acquired more rapidly, and reproduced more accurately, than those learned without. Sports performance at the highest levels require[s] good technique and good timing. These are skills learned during training, so enhancing the efficiency of learning during the training phase will be of greater benefit at competition time. I suggest that an athlete could use these techniques to make training more efficient and thereby gain an advantage. (Davis 2013, 652)

It is not difficult to predict, therefore, that neuroscience's application to training and enhancement in sport is only just beginning given that this powerful instrument is already in the hands of coaches and training staff. Both kinds of brain stimulation can have a great effect, for example, on archery by reducing tremor. They can also greatly impact tennis since the possibility of success is closely related to repeatedly winning the serve.[29] These are all trainable skills that can also be improved using these techniques. In any case, due to the great diversity of athletic competition, the acceptance and usefulness of these brain stimulation techniques may also be quite diverse; thus, any decision that is taken with regard to them ought to take the specific type of sport into account.

Nonetheless, transcranial stimulators are not exempt from problems or drawbacks. In the following, some of the most evident ones will be examined.

6. Some criticisms of cognitive enhancement and theories of sport

The first critical observation that must be made is that the effectiveness of these techniques has not been tested under real competitive sport conditions or for specific actions. In addition, as Davis points out, the tests have not been carried out on athletes but rather on normal people, that is, non-athletes. As a result, Davis is sceptical about applying them to elite sports.

A second objection would be that with neuroenhancement the athlete would not need to strive to make an effort or a sacrifice to obtain results. The acquisition of physical power, or other relevant skills for the sport would make the physical sacrifice of the sportsman irrelevant to obtaining the sport victory. But the impact of neurodoping in sport practice

will likely not affect equality to such an extent. Neurodoping, at least in its current state, does not offer such miraculous effects that the athlete will obtain stratospheric results. The athlete still needs to train and make sacrifices to ensure top performance. In the end, neurodoping simply offers a small difference in the results; if an athlete were to rely on the miraculous effects of a pill or an electromagnetic session and stop training, it is highly unlikely that he would be in the elite of his field.

Another type of objection stems from dangers of potential generalized use, as well uncontrolled use by fans who are also athletes. The effects of doping in the gyms and athletic facilities of sport aficionados are well known, making it highly likely that the use of cognitive enhancers and cranial stimulators may also become widespread. Clearly this could bring about pressing public health concerns resulting from irreversible harm to the brain that could be caused by improper use.

A more general objection refers to cognitive enhancement. Certainly, any attempt to intervene in the brain can raise hotly debated issues such as authenticity and practical relevance when it comes time to judge the actions of an individual. There are others, such as McNamee and Loland, who believe that the imposition of paternalistic measures is in fact justified in that they keep sport from becoming the field for experiments in which athletes are used as human guinea pigs.

The first objection is that a possible side effect of this kind of enhancements is the creation of inauthentic personalities. The second objection argues that enhancers would change our mind in such a way that it will be difficult for us to attribute moral accountability. There are two possible answers to both criticisms. Firstly, it is unclear why the enhanced self is evaluated as inauthentic, especially if the enhancement is ongoing rather than momentary. The sport person who has inferior memory skills could negate these traits as the inauthentic by-product of a biological weakness. The authentic person is the one who fights against their imposed weak nature.[30]

Regarding the second objection, Kahane (2011) offers an interesting defence of enhancers as authentically coherent insofar as one tries to conform to one's own desires, preferences or values.[31] For these points of view, these techniques represent no more than advances over traditionally used techniques in education.

Such discussion warns of the possible consequences of enhancement for sporting purposes. Under the current anti-doping policy, athletes have the capacity to make informed choices about the use of enhancers in terms of their short- and long-term impacts: the possible enhancement (or not) of sport performance relative to a potentially reduced (or higher) level of welfare in future life.

Finally, what remains to be made known is the position taken by the World Anti-Doping Agency. Whether these substances should be included on the agency's famous list of prohibited substances is not a simple issue. Certainly, as we have just seen, the effects of these techniques on athlete performance are as of yet unknown; thus it would be risky to venture an opinion on that matter. But given their characteristics, these stimulation techniques still may receive identical treatment to hyperbaric or cryogenic chambers, whose effects are similar to those included on the WADA list although these treatments are not included in it. In any case, transcranial techniques would avoid the objections to technological unfair play given that their affordability would increase athletes' equal access opportunities.

It can be clearly seen that all of these matters are intertwined. It is also obvious that whatever decision is finally adopted by WADA regarding the use of these techniques must

be based on some criteria that lend robustness to the argument. That is, the criteria should be morally based. Perhaps for that reason, it is advisable to finalize this article by turning to what Loland deems acceptable uses of technology, unacceptable uses of technology and uses that are of value to technology in sport.[32]

From our point of view, cognitive enhancement techniques open up an interesting field in terms of sport performance, an arena which demands close examination. In the first place, the lack of conclusive evidence regarding their efficacy under actual competitive conditions leads us to recommend not taking hasty decisions regarding their use. That is to say, they may or may not end up being of value to sport, but in order to know this, it is necessary to explore the possibilities.

Do not misunderstand: we are not defending a genuinely instrumentalist vision of sport.[33] Our position is somewhere between what Loland calls 'narrow and wide ideal-typical theories of sport'.[34] It is our opinion that sport should be open to the advances of scientific and technological knowledge. Among other things, this is because with them new frontiers to sport performance are opened up for exploration. And the Olympic motto, *citius*, *altius*, *fortius*, that is, progression in performance, seems to be an intrinsic part of modern sport. That does not mean that performance should be the true normative standard of sport. In reality, reliable evaluation of athletic performance can only be aptly understood when other intrinsic values of sport are also taken into account. In addition, it is not necessary to launch into a prolonged discussion regarding what these values are and what interpretations should be made based on them. Be what they may, they are not totally separate from sport performance, as claimed by the wide theory of sport that Loland defends and we partially endorse. Rather the opposite is true. Sport performance is a defining characteristic in highly competitive sport. It has been this way since the beginning and continues to be so in current times. Whatever the appropriate uses may be for technology, in order to attain them, it goes without saying that there is ample room for disagreement in this area. Whatever the disagreement, however broad it may be, to be adequately understood, it must be founded on some common ground, which in this case is none other than the link between the ends and the means. That is to say, the compatibility thesis.

7. Conclusions

As was seen at the beginning of this article, elite athletes are characterized by their pushing of the limits of physical and psychological performance. In fact, the exquisite combination of both is what is said by some authors to characterize the athletic identity or sport personality. But it is equally true that competitive sport has always made use of technology to constantly improve performance and in this way make good on the Olympic motto.

All of this leads to a recurring debate regarding the legitimacy of using enhancement techniques and substances in sport. In all likelihood, this debate has gone hand in hand with the evolution of sport itself. After all, the difference between the usage of natural substances with enhancement effects in the past and the current techniques of present times lies in the how and not the what. Consequently, it is unsurprising to catch glimpses of a near future in which there is increasing interest in biotechnological enhancements since these enhancements are likely to offer more potent and safer possibilities.

In current times, available techniques and substances not only allow improved physical abilities. The scientific evidence regarding the connection between the brain (cognitive and

emotional factors) and the rest of the human body on sport performance requires that attention be paid to the enhancement of psychological abilities, and with them athletic performance, which is part of the scientific research agenda.

The second part of the article focused on the importance that cognitive abilities have on sport performance and in what way the extraordinary advances in knowledge about the brains can affect not only better comprehension but also better manipulation of the athlete's brain in order to improve their athletic performance. For this reason, the growing importance of neuroscience and its techniques as applied to the world of sport can be easily understood.

To get a general overview of these neuroscience techniques, we have analyzed the impact of two cognitive enhancers (modafinil and methylphenidate) and of transcranial stimulators on sport performance. As we have seen, transcranial stimulators allow neurons to be excited, directly influencing sport performance and thus improving time to fatigue or the ability of athletes to acquire new skills.

Next, we turned to the objections to using these sport performance enhancing techniques and their eventual inclusion on WADA's prohibited substance list. Furthermore, we echoed the potential danger that the widespread usage of these stimulators would have on athletes, given the fact that they are economically accessible. All of this does nothing but highlight the fact that this is an interesting and necessary debate that must be confronted by sport theory.

To conclude this article, we have highlighted some of the normative problems spawned by the use of these techniques in sport. We pointed out that given the lack of conclusive evidence for their efficacy in actual competitive situations, it would not be prudent to adopt definitive decisions with regard to them. We also maintained that, as occurs with any other brain intervention, they must be governed by meticulous respect for the principle of precaution in order to maintain the absence of undesirable harm to the primary organ of the human being. Lastly, we attempted to balance the arguments in favour of the advantages provided by easy access with those that warn against the possible risks to public health generated by inappropriate usage of the same.

In any case, all of these objections can explain and justify the adoption of restrictive measures in sport, but we must not forget that all of them refer to the technique, and as such, this objection will be surpassed by advances in the area. What will not vary is the normative question regarding compatibility with values of sport. Our position in this regard is moderately positive, or if you will, close to what Loland calls the 'narrow theory'. That is, we consider the compatibility thesis to be more hopeful because it allows high levels of performance to be attained without betraying the internal values of sport.

All said, given that this is a recurring debate in sport theory which has enormous practical relevance for athletes, it would be fitting to pay attention to scientific evidence and not hastily or contradictorily conclude, as the WADA list seems to do, that it is justified to ban some of these techniques while permitting others, such as hyperbaric chambers or cryogenics, which have identical effects.

Notes

1. McNamee (2008, 37).
2. Druzheyskaya et al. (2008).
3. http://whqlibdoc.who.int/publications/2010/9789241599979_eng.pdf.

4. Druzheyskaya et al. (2008).
5. Luthar et al. (2000, 435).
6. Morgan et al. (2013, 552).
7. Carrio (2015) Clearly, it is difficult to understand that individuals whose physical and psychological performance exceeds habitual norms of performance, but who are subject to accidents or illnesses just as any other person, may be extremely restricted in their ability to use of certain therapeutic substances. This restriction may virtually nullify the extraordinary characteristics of the individual's physiology.
8. Gaffney (2015).
9. Brewer et al. (1993)
10. Danish (1983)
11. 'Sport technology, then, are human-made means to reach human interests and goals in or related to sport' Loland (2009, 153).
12. Ibid.
13. Particularly what has been called 'technology administered by experts'; Loland (2009, 155)
14. Sceptics can always object that there is an ongoing debate in neuroscience regarding the mind-body duality. But it should be noted that the techniques of interest here, such as neuron stimulation, operate on the body part in this debate, i.e. the brain. As a result, the debate is becoming inconsequential in this regard.
15. Although we cannot detain ourselves on this point, it is worth differentiating between brain interventions that affect cognitive abilities from those that influence moods or emotional states.
16. Loland (2009, 153)
17. Ibid.
18. The case of the Australian skier, gold medallist in the winter Salt Lake Olympic Games, perfectly exemplifies the role of luck in competition. Certainly Bradbury qualified thanks to the disqualification of one of the favourites, Canadian Marc Gagnon. In the last turn of finals, the first four who all led Bradbury by more than 15 metres all fell, allowing Bradbury to be named the winner. It was the first Olympic metal won by a competitor from the southern hemisphere.
19. In some way, the distinction between different types of athletic competition is interesting because doping does not uniformly affect all sports. This is what S. Loland calls the 'thesis of vulnerability', which suggests that the essence of certain sports would be more greatly affected by doping than others. As we will see further on, something similar occurs with emotional doping.
20. Platonic and Cartesian dualism have been the dominant conceptions of the mind and body in sport, establishing the comparison between body and machine. Recently there has been noteworthy attention paid to the relation between both of these factors in sport performance. See Kretchmar (2013) and Illundáin (2013).
21. Some of these practices are imagery training and cognitive restructuring.

    Imagery training is the 'symbolic repetition of a physical activity in the absence of any large muscle movement.' The athlete methodically, consciously, and repeatedly imagines a sport action without actually physically executing it at the same time. The objectives of imagery training are: (a) facilitating motor skills to enhance practical execution; (b) controlling attention and concentration; and (c) accelerating recovery from injury.

    Cognitive restructuring is a 'set of techniques which intend to directly change the athletes' thoughts to better face the demands of competition'. The aim of this is to: (a) improve athletes' self-confidence; (b) strengthen motor activities; and (c) control attention and concentration. Vid. Sánchez and Lejeune (1999), 23.
22. To give an approximation of the term, neuroscience consists of the study of brain mechanisms which form the basis for an individual's essential cognitive functions: the ability to remember, argue, decide, etc. These functions can be observed through powerful instruments such as functional magnetic resolution imaging (fMRI), positron emission tomography (PET) and electroencephalography, which monitors the electrodynamic flow of neurons.
23. At the outset, it was used in medicine to treat attention deficit and hyperactivity disorder. Nevertheless, there is current widespread perception that it can have similar effects on people who do not suffer from hyperactivity or attention deficit. The consequence has been its spread

to university and secondary school students who have discovered that stimulants improve concentration. In this way they are being used not only for improvement in studies but also to improve exam performance. They have been shown to be used among university professors and researchers. Methylphenidate and modafinil are currently on the list of banned substances. Presidential resolution of 20 December 2013 Supreme Council for Sport, by which substances and methods are prohibited in sport. Dubljević and Ryan, 2015 'Cognitive enhancement with methylphenidate and modafinil: conceptual advances and societal implications', Neuroscience and Neuroeconomics: 4.

24. According to data published by NDCHealth, Adderall XR is on the list of the 200 most-sold medications in the United States. Specifically, it is number 69 and generated 730 million dollars in revenue for the last year. It is immediately followed by another stimulant Concerta (extended release methylphenidate) with sales of 270 million. Provigil (modafinil) generated 420 million in income, just below another drug that intuitively seems much more popular than the stimulants: fluoxetine (an antidepressant popularized in the 1990s under the trade name Prozac; available today generically) with sales of 450 million. Wikipedia: http://es.wikipedi-a.org/wiki/Estimulante. Last accessed 30/12/2013.
25. Reardon and Creado 2014, 98.
26. Peterson (2008).
27. According to the standard characterization, stimulants are drugs which increase levels of motor and cognitive activity, reinforce wakefulness, and the state of alertness and attention. The US Anti-Doping Agency defines a stimulant as 'An agent, especially a chemical agent such as caffeine, that temporarily arouses or accelerates physiological or organic activity'.
28. However, its inclusion on the list of prohibited substances is questionable to the extent that its enhancement effect is within 'normal' (not transhuman) limits and the risks it presents to health are not significant. It should be then asked whether its inclusion on the list of banned substances is justified.
29. Adjusting how the ball is struck and addressing it to a specific area of the tennis court.
30. This argument is a personal version of Foddy argument against the critics to mood enhancement based on inauthenticity:

    > It seems highly plausible that an athlete would repudiate his tremor, or his nausea, or his perspiration in this manner. To tell him that his tremulous, sweaty, and nauseated self is his true self seems no more reasonable than telling dieters that it would be more authentic for them to remain overweight.

31. 'If authenticity involves being true to oneself, or to one's values, then there is a sense in which … when one uses mood enhancers, one is at most conforming to one's values.' (Kahane, 170).
32. Loland (2009, 156).
33. Russell (2005).
34. According to Loland there are three Ideal-typical theories of sport that express alternative normative interpretations of sport, namely, the 'relativist', the 'narrow' and the 'wide' theories. The narrow one embraces some technological optimism. Even if it could be, as Loland says, 'politically incorrect', the alternative understanding of the values of sport that it supports is 'clear and consistent' as Loland (2009, 156–157) himself recognizes. On the other hand, the wide theory is not blind to developments and innovations in sports. Even if it is critical to performance-enhancing expert- ad-ministrated technology, 'there are varying opinions among wide theorists about the justification of harmless variants such hypoxic tents' (Loland 2009, 158).

Acknowledgement

We thank the anonymous reviewers from Sport, Ethics and Philosophy for their careful reading of the article that help us to improve it.

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Alberto Carrio Sampedro http://orcid.org/0000-0002-8482-0190

References

BREWER, B.W., J.I. VAN RAALTE, and D.E. LINDER. 1993. Athletic identity: Hercules' muscles or Achilles heel? *International Journal of Sport Psychology* 24: 237–254.

CARRIO, A. 2015. When better is worse. On the therapy/enhancement distinction in sports. *Sport, Ethics and Philosophy* 9 (4): 413–426.

DANISH, STEVEN J. 1983. Musings about personal competence: The contributions of sport, health, and fitness. *American Journal of Community Psychology* 11 (3): 221–240.

DAVIS, N.J. 2013. Neurodoping: Brain stimulation as a performance-enhancing measure. *Sports Medicine* 43 (8): 649–653. doi:10.1007/s40279-013-0027-z.

DRUZHEVSKAYA, A.M., A. AHMETOV, and V.A. ROGOZKIN. 2008. "Association of the *ACTN3* R577X polymorphism with power athlete status", in Russians. *European Journal of Applied Physiology* 103: 631–634.

DUBLJEVIĆ, V. and C.J. RYAN. 2015. Cognitive enhancement with methylphenidate and modafinil: conceptual advances and societal implications. *Neuroscience and Neuroeconomics* 4: 25–33.

ERONIA, O. 2012. Doping mentale and concetto di salute: a possibile regolamentazione leg-islative. *Archivio penale* 3: 1–23.

FODDY, B. 2011. Enhancing skill. In *Enhancing human capacities*, edited by R. Ter Muelen, J. Savulescu, and G. Kahane. Oxford: Blackwell: 313–325.

GAFFNEY, P. 2015. The nature and meaning of teamwork. *Journal of the Philosophy of Sport* 42 (1): 1–22.

GOODALL, S., G. HOWATSON, L. ROMER, and E. ROSS. 2012. Transcranial magnetic stimulation in sport science: A commen-tary. *European Journal of Sport Science* 14 (Suppl 1): S332–S340.

HOBERMAN, J. 1992. *Mortal engines. The science of performance and the dehumanization of sport*. New York, NY: The Free Press.

ILLUNDÁIN, J. 2013. Moving wisdom. Explaining cognition through movement, Fair Play. *Revista de Filosofía, Ética y Derecho del Deporte* 1.

KAHANE, G. 2011. Reasson to Feel, Reasons to Take Pills. In *Enhancing human capacities,* edited by R. Ter Muelen, J. Savulescu, and G. Kahane. Oxford and Malden, MA: Blackwell: 166–178

KANAI, R., L. CHAIEB, A. ANTAL, V. WALSH, and W. PAULUS. 2008. Frequency-dependent electrical stimulation of the visual cortex. *Current Biology* 18 (23): 1839–1843.

KRETCHMAR, S. 2013. Mind-body holism, Paradigm and Education. *Fair Play. Revista de Filosofía, Ética y Derecho del Deporte* 8 (1): 28–43.

LEUNES, A. 2011. *Sport psychology*. London: Icon Books.

LUTHAR, S.S., D. CICCHETTI, and B. BECKER. 2000. The construct of resilience: A critical evaluation and guidelines for future work. *Child Development* 71 (3): 543–562.

LOLAND, S. 2009. The ethics of performance-enhancing technology in sport. *Journal of the Philosophy of Sport* 36 (2): 152–161.

MCNAMEE, M. 2008. *Sports, virtues and vices. Morality plays*. London: Rout-ledge.

MERKEL, R., G. BOER, J. FEGERT, T. GALERT, D. HARTMANN, B. NUTTIN, and S. ROSAHL. 2007. *Intervening in the brain. Changing psyche and society*. Berlin: Springer.

MORGAN, PAUL B.C., DAVID FLETCHER, and MUSTAFA SARKAR. 2013. Defining and Characterizing Team Resilience in Elite Sport. *Psychology of Sport and Exercise* 14 (4): 549–559. doi:10.1016/j.psychsport.2013.01.004.

PETERSON, D.. 2008. Performance Enhancement Common in Sports. *Live Science*. Available at http:// www.livescience.com/5230-performance-enhancement-common-sports.html (accessed 17 October 2016).

REARDON, C.L. and S. CREADO. 2014. Drug abuse in athletes. *Substance Abuse and Rehabilitation* 5: 95–105.

RUSSELL, J.S. 2005. The value of dangerous sport. *Journal of the Philosophy of Sport* 32 (1): 1–19.

SÁNCHEZ, X. and M. LEJEUNE. 1999. Práctica Mental y deporte. ¿Qué sabemos después de casi un siglo de investigación?. *Revista de psicología del deporte* 8 (1): 21–37.

SANDBERG, A. 2011. Cognition enhancement: Upgrading the brain. In *Enhancing human capacities*, edited by J. Savulescu, R. ter Meulen, and G. Kahane. Malden, MA; Wiley-Blackwell: 71–91.

TAMORRI, S. 2004. *Neurociencias y deporte. Psicología deportiva y procesos mentales del atleta.* Barcelona: Ed. Paidotribo.