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Neuro-doping and the value of effort in endurance sports

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ABSTRACT:

The enhancement of athletic performance using procedures that increase physical ability, such as anabolic steroids, is a familiar phenomenon. Yet recent years have also witnessed the rise of direct interventions into the *brain*, referred to as "neuro-doping", that promise to also enhance sports performance. This paper discusses one potential objection to neuro-doping, based on the contribution to athletic achievement, particularly within endurance sports, of effortfully overcoming inner challenges. After introducing the practice of neuro-doping, and the controversies surrounding it, I describe two major mechanisms some have proposed to explain how it might produce its putative performance-enhancing effects. I then clarify the notion of effort, and its relationship to neuro-doping. I also briefly address common concerns about access and safety. My central argument invokes considerations of effort to maintain that we have at least a significant reason for prohibiting the use of neuro-doping in officially regulated endurance competitions – though only conditional upon a specific set of empirical assumptions. I consider three possible objections: that neuro-doping is no different from widely accepted enhancement methods, that it can make athletic competition fairer, and that a broader range of factors can compensate for a reduced scope for effort than I recognize. I ultimately conclude that these objections do not refute the argument from effort, while stressing nonetheless that this argument applies more clearly to hypothetical improved forms of neuro-doping than to existing ones, and is not meant to offer a final overall verdict on how neuro-doping should be regulated.

Keywords: Effort, Enhancement, Motivation, Neuro-doping, Sport, tDCS

1. Introduction: what is neuro-doping?

The enhancement of athletic performance using procedures (typically banned by anti-doping agencies) that increase physical ability, such as anabolic steroids, is a familiar phenomenon. Yet recent years have also witnessed the rise of direct interventions into the *brain* (as opposed to the rest of the body) that promise to also enhance performance in sports – what is now referred to as "neuro-doping" [1]. One example are certain psychoactive drugs, like amphetamine or modafinil [1]. But a more advanced intervention that has been attracting increasing attention in this context, and is most closely associated with the phrase "neuro-doping", is transcranial electrical stimulation of the brain (tES), and particularly transcranial direct current stimulation or tDCS [1, 2]. A number of scientific articles have discussed its

potential to enhance athletic performance, and whether sports governing bodies should consider banning its use. Some professional athletes have already been reported to be using tDCS devices for training [3].

A few systematic reviews and meta-analyses of this scientific literature have already been conducted. They do not all come to the same conclusions about the potential of tDCS to enhance athletic performance.[1] This lingering uncertainty suggests the need for caution about the idea that tDCS and other forms of neuro-doping might enhance athletic performance to any substantial degree. Without taking that hypothesis for granted, this paper will consider one concern that would arise should it nonetheless prove correct at some point: the concern that neuro-doping might threaten the admirable nature of athletic achievements by removing or diminishing the need to effortfully overcome obstacles to peak performance. For the purpose of evaluating that concern, the particular way in which neuro-doping methods like tDCS might end up enhancing athletic performance is key. Furthermore, my discussion will concentrate on the enhancement of *endurance* performance, as it is in this context that the role of perceived effort for ultimate performance has been analysed most closely, for instance in the so-called "psychobiological model" of endurance performance, which I shall explain in the next section. I remain open as to whether my conclusions might apply to other forms of performance enhancement via neuro-doping.

The rest of this paper is divided into six different sections. In section 2, I describe two major mechanisms that have been proposed to explain how neuro-doping might produce its purported performance-enhancing effects. In section 3, I clarify the notion of effort, and its relationship to neuro-doping. Section 4 briefly addresses some concerns, common in discussions of performance enhancement in sport, about access and safety. Section 5 lays out my central argument against allowing neuro-doping in officially regulated endurance competitions,[2] based on the role, in producing admirable athletic achievements, of strenuously striving to perform at one's best (the "argument from effort", for short). I contend

[1] Compare for instance the systematic review by Luca Angius and colleagues, who found evidence that tDCS improves endurance (in 60% of the studies they reviewed), strength, power and anaerobic capacity" (in 57% of the studies) [2]; with the more skeptical verdict of Darias Holgado and colleagues in their recent meta-analysis [4].

[2] These involve professional events, as well as any amateur ones where regulations are enforced by an official body to ensure fair competition. They do not involve activities like a competitive run between friends, which is arguably not an appropriate target for such regulation (even though the reason I adduce against the use of neuro-doping might also apply to participants in such an activity).

that *if* neuro-doping does substantially limit the role of such striving in determining ultimate performance, the argument provides a significant reason for prohibiting the practice in such competitions. Section 6 considers three possible objections to my argument: the claim that neuro-doping is no different from widely accepted enhancement methods, the view that it can make athletic competition fairer, and the suggestion that a broader range of factors can compensate for its impact on effort than my own analysis recognizes. I reply to each of those objections in turn, ultimately concluding that they do not refute the argument from effort. In section 7, however, I stress that my analysis aims to present a strong reason in favour of banning neuro-doping in the relevant contexts, but not necessarily to firmly adjudicate on how this reason should be weighed against other, potentially competing considerations. Furthermore, the existence of that very reason is dependent upon a specific set of empirical premises. Since such premises are not currently supported by conclusive evidence, the argument from effort applies more clearly to hypothetical improved forms of neuro-doping than to existing ones.

2. How does neuro-doping work (if it does work)?

A variety of mechanisms have been proposed to account for the supposed enhancing effects of tDCS on athletic performance. Two such putative mechanisms, of particular relevance to our discussion, are the following:

1) First, it has been hypothesized that tDCS might reduce the perception of effort during peak performance by increasing corticospinal excitability, thereby demanding only smaller excitatory inputs to the primary motor cortex (M1) to produce the same level of physical performance [2].[3] This would mean for instance that a cyclist who used tDCS could pedal at the same high intensity without it feeling as hard as it otherwise would, thus allowing her to either pedal harder, or to persist at the same intensity for longer, resulting in an improvement in her cycling performance. In this context, feeling "less hard" will primarily mean less strenuous, although some have also

[3] Once again, other authors treat that hypothesis with scepticism. Based on their meta-analysis, Holgado and colleagues thus write that "tDCS is not as effective as it appears to reduce perceived exertion", as a result of which they "cannot conclude that tDCS modulates subjective outcomes of exercise performance" ([4], pp. 247-8).

suggested that tDCS might reduce fatigue-related muscle pain, as distinct from perceived effort [5, 6]. In any case, there is substantial overlap between the ethical issues raised by these two putative mechanisms.

2) Secondly, it has also been proposed that tDCS might enhance motivation – that is, the willingness to exert strenuous effort, as distinct from the perception that less effort is needed to achieve the same performance [6]. When it comes to psychoactive drugs, enhancing effects on motivation have also been reported in some studies of psychostimulants like amphetamine and methylphenidate, which seems in line with the impact of such substances on the dopamine system [7].

To be clear, I do not mean to posit a strict separation between these two mechanisms. On the contrary, interactions between them seem likely. For instance, if the effort required to keep going in a race feels extremely demanding, a runner might lose the motivation to try any further. Furthermore, the two mechanisms need not be mutually exclusive: it seems possible that neuro-doping might produce its supposed enhancing effects on athletic performance via both pathways at the same time, at least in some cases. Nonetheless, they are at the very least conceptually separable. The fact that exercising at a given intensity might feel easier thanks to neuro-doping does not *mean* that one is now more motivated to exercise at that intensity – although the latter might certainly often follow from the former.

It is worth highlighting that these are not the only possible explanations for the putative enhancing effects of neuro-doping interventions. Further studies, monitoring for instance brain activity during exercise following the use of tDCS, are needed, first to better establish the reality of those enhancing effects, and secondly to clarify their origin, assuming they are indeed real [2]. Nonetheless, for the purposes of an ethical discussion focused on endurance sports,[4] these two possible mechanisms are of particular relevance. Any interventions that might help reduce the perception of effort during exercise, or that might increase the willingness to exert strenuous effort for sustained periods, would likely be of interest to endurance athletes seeking to enhance their performance. Furthermore, as we will see, they

[4] Here I understand the category of "endurance sports" as encompassing all sports in which endurance is clearly a significant factor in the production of elite performance: for instance, tennis, running, or cycling. A reviewer correctly observes that other sports, like golf or chess, may have an endurance component and thus also be relevant to my argument, despite not being paradigmatic cases of endurance sports. I focus on paradigmatic examples here in order to illustrate my points as clearly as possible.

raise some concerns that would not seem to apply, say, to a direct improvement of muscular strength.

How should we anticipate that effective neuro-doping interventions would be used? Assuming use in competition were feasible, either because it were allowed or because it could successfully avoid detection, it seems most likely that athletes would turn to such interventions both during training and during competition (provided that no health consequences emerged of such severity that they made chronic use unappealing to most). Indeed, it has been suggested that tDCS could help make training more efficient [8], and it does seem that enhancing one's ability to push oneself hard during workouts could in turn yield improvements in physical ability.[5] Yet the use of neuro-doping during actual competition would also seem important, insofar as using such interventions only during training might risk depriving the athlete of the mental edge she would otherwise enjoy in actual competitions, where she would have to perform in a diminished (albeit "normal") mental state. Using them only for competition, by contrast, might cause the athlete to miss out on their potential benefits for training, and to find herself in unfamiliar territory when she did use them.

I shall ultimately argue that when discussing the regulation of neuro-doping interventions, it seems more appropriate to focus on its use in competition. Before I say more about this, however, some clarifications about the nature of the concept of "effort" are in order.

3. Neuro-doping and the notion of effort

The concept of effort is ambiguous to some extent. So far, I have been talking about *perceived* effort, which as we have seen seems to depend on the level of input into M1. Perceived effort is the familiar psychological experience of strenuous striving towards a certain goal, which in the sports context will be physical performance of some kind. This might be contrasted with *actual* effort, which itself can be either physical or mental in nature.

[5] As a reviewer notes, these physical benefits could be expected to persist during competition, even if the athlete were not using neuro-doping then. This in turn raises the question whether this would also hold true of neuro-doping's *mental* benefits, because its repeated use during training produced durable changes in the athlete's brain. As far as I am aware, this latter possibility remains speculative at this stage.

Physical effort, the kind most relevant to the context of sports,[6] might be said to encompass the workings of a person's body when she is, for instance, in the process of running a race, such as rhythmic breathing, contraction of the muscles leading to coordinated movements of the legs and arms, etc. It also arguably includes the motor commands from M1 that control those bodily workings.

Other authors use a different terminology to refer to what I have just described as physical effort (and which one could also refer to as physical "work"). For example, Hannah Maslen and colleagues speak instead of the act of expanding energy, which they distinguish from the exertion of effort, the latter being equivalent on their view with the idea of perceived effort ([9], p. 5). Which exact phrase we prefer to use here is not crucial, as long as it captures the central distinction at stake. Delivering an athletic performance will necessarily require expanding energy (i.e. exerting "actual", physical effort), and in the case of professional competition, will also require the athlete to *experience* substantial effort (which, as Maslen and colleagues point out, is associated with an aversive phenomenology). However, more modest forms of physical performance, such as running at a comfortable pace, will involve some expansion of energy, yet little to no (perception of) effort.

The influential "psychobiological model" of endurance performance, developed by Samuele Marcora [10], can help us understand the unique contribution that neuro-doping might, in principle at least, be able to make to the enhancement of athletic performance. Namely, it promises to enhance it without any need to alter an athlete's raw *physical* ability.[7] One aspect of endurance performance highlighted by the psychobiological model is that the act of quitting, or slowing down, does not always, or even typically, result from the athlete having reached her absolute physical limits, resulting in momentary muscle failure or physical exhaustion (e.g. her legs don't "respond" any longer). Rather, a key factor is mental in nature: the physical work required, say, to maintain a certain running speed, feels like "too much" (i.e. perceived effort is too strenuous), and the task is therefore abandoned (Marcora, quoted in [11]). Whether by making a given level of physical work feel easier (i.e. less strenuous, or less painful) to perform, or by boosting the athlete's willingness to perform that physical

[6] Not exclusively, of course: mental effort, as reflected e.g. in the search for strategies to outdo one's opponent, is also relevant.
[7] Although, as mentioned previously, the mental benefits of neuro-doping could in turn facilitate gains in physical ability, these benefits would be valuable to athletes beyond this particular effect.

work or exert that physical effort, neuro-doping offers the prospect of facilitating the task of endurance athletes seeking to push themselves to their physical limits (and, ultimately, maximizing their performance).

We now have a basis to discuss some of the ethical implications of neuro-doping's impact on the role of effort (understood as strenuous striving to overcome inner barriers) in athletic performance. Before we move on to that particular issue, however, let me say a few words about two distinct ethical concerns that quickly come to mind: those of equal access, and safety.

4. Access and safety issues pertaining to neuro-doping

A common concern about doping practices of any kind in sport, which neuro-doping might also elicit, concerns the possibility that the relevant interventions, should they be allowed in competition, will only be available to athletes coming from favorable socio-economic backgrounds, putting the less fortunate (e.g. some athletes from developing countries) at an unfair disadvantage. I shall have a few things to say about considerations of fairness in subsection 6.2. However, so as not to overextend the scope of this paper, I shall mostly leave questions of equal access aside here, without seeking to dispute their importance. For the purposes of my discussion, we can assume a situation in which access to neuro-doping interventions among athletes is at least reasonably fairly distributed.[8]

Furthermore, as we have already touched on, the use of neuro-doping also raises concerns about the safety of athletes. The effects of chronic use of tDCS in healthy subjects are still not fully known. Such use of psychoactive drugs like stimulants raises the specter of addiction, among other risks. Moreover, even leaving these potential side effects aside, one might worry that the general mode of action of neuro-doping (irrespective of the particular intervention under consideration) could prove harmful to athletes. For instance, one might assume that when physical work feels too strenuous, or when muscle pain sets in, an athlete's body is giving her a signal that she is pushing herself too hard. Repressing that signal with the help of neuro-doping (especially on a regular basis), one might fear, will increase the

[8] For a critique of fairness-based objections to the legalization of neuro-doping in sport, see [11].

athlete's risk of injury, or other health hazards.

Such concerns do seem reasonable, given that injuries and other physical issues from overtraining are already a reality, both among professional and amateur athletes. That said, it is not clear that, taken on their own, these concerns provide a persuasive justification for an outright ban on neuro-doping. Indeed, while it certainly seems possible that such interventions could be used in an unsafe manner, that does not mean it is unavoidable. According to Alexis Mauger, an expert on the use of tDCS in athletic competition and frequent collaborator of Marcora, "pain is important during exercise but the pain response can be a bit overzealous" [12]. Learning to keep pushing through pain or fatigue is one key aspect of the process of becoming an elite athlete. The fact that it is in principle possible to go too far in that process does not mean that athletes should simply accept their initial thresholds for pain or fatigue if they are to exercise "safely".

It thus does seem in principle possible to use effective neuro-doping interventions in a responsible manner – although, should such interventions make it easier for athletes to push their bodies dangerously hard, they might require identifying a "maximum" level of exercise intensity or frequency that can still be considered safe, and ensuring one does not cross that limit, even if neuro-doping makes it easier to do so. The rest of this paper will therefore assume that considerations of safety do not warrant prohibiting all forms of neuro-doping in officially regulated competitions, yet will still emphasize the relevance of such considerations to my core argument, based on the value of effort in endurance sports, which I shall present in the next section.

5. The value of effort in endurance sports

The central objection to the use of neuro-doping that this paper proposes to consider starts from the premise that the challenge of pushing oneself in the face of adversity, whether in the form of fatigue, muscle pain, or difficulties with motivation, is an important contributor to the display of athletic excellence in endurance sports.[9] Whether by making the process of

[9] At the very least, I hold that pushing oneself in this way is admirable when it is coupled with talent, thus resulting in high athletic performance. While I am inclined to find such strenuous striving admirable even when

pushing oneself to one's physical limits feel easier, or by reducing or removing the need to cultivate a steadfast will to keep pushing oneself, neuro-doping risks diminishing the admirable nature of the relevant achievements – or so the objection goes. This would provide at least a significant reason not to allow neuro-doping in (endurance) sports, insofar as part of why we properly value such sports is that they provide a test (and, in the best cases, a public display) of such excellences of character.[10]

Some famous cases in the history of sports illustrate the idea at the root of this objection. Consider for instance the longest singles Grand Slam final in tennis history, contested between Novak Djokovic and Rafael Nadal at the Australian Open in 2012. The match featured a war of attrition between the two players that lasted a total of five hours and 53 minutes. Especially in the late stages of the contest, the players' struggle to keep playing their best tennis against mounting fatigue and muscle pain from their punishing rallies was apparent to all. During the trophy ceremony, they were barely able to stand, and were eventually both provided with chairs. One key reason why this tennis match is now remembered as one of the greatest of all time arguably lies in the way both players managed to push themselves through those mental challenges until the very end, yielding an outstanding athletic performance. Had Nadal and Djokovic used neuro-doping to achieve a similar outcome more easily, the match might have looked "cleaner" at the end, with less grunting and panting, and shorter transitions between points, yet the player's accomplishments would arguably have been diminished to some extent.[11]

A similar diminution would intuitively seem to apply to other famous feats of endurance, if we assume that they had been facilitated by neuro-doping. One example among others would be the duel between Roger Bannister and John Landy in what has been termed the "Miracle Mile" race during the 1954 British Empire Games in Vancouver. On that occasion, both runners spurred each other on to reach their physical limits, resulting in both of them

someone has little talent (at least while they are still figuring out what they are capable of), I take no firm stand on this latter issue here, as I am only discussing cases of the former type.

[10] I am talking here about one specific aspect of character, as manifested in the context of sports competition. It is no doubt possible for athletes to demonstrate excellence by consistently pushing themselves hard, while simultaneously exhibiting much less flattering character traits (say, being overly prone to anger, or a sore loser).

[11] One technical challenge with the use of neuro-doping in the context of a tennis match would be that the putative enhancing effects of tDCS only seem to last for about an hour or so after stimulation [13]. To be effective in alleviating fatigue, the technique might then need to be applied at a later stage (or at later stages, if the stimulation could be repeated) in the match, rather than shortly before its start.

completing the mile in under four minutes. When it comes to more protracted races, similar remarks seem applicable to the contest between Dick Beardsley and Alberto Salazar in the 1982 Boston Marathon, the story of which was told in the 2006 book *Duel in the Sun* [14].

Finally, the admirable nature of the triumph over mental challenges in one's quest for success is also demonstrated by cases of athletes refusing to concede defeat in seemingly desperate situations. Tennis players like the Williams sisters have partly built their reputations on their numerous extraordinary comeback wins in the biggest tournaments. "Come-from-behind" victories such as that of Billy Mills in the 10,000-metre final at the 1964 Olympics are now landmarks in the history of running. Yet feats of resolve are not only accomplished on the biggest occasions, but also in the more mundane circumstances of training sessions, where consistently finding the necessary motivation can prove tricky even for top athletes. If neuro-doping could provide athletes with a stable supply of resolve, ensuring that they would work hard during both training and competition, it would thereby supplant, or at least reduce the challenge of successfully grappling with one's human weaknesses – a challenge which, again, is arguably among the paths through which excellence can get manifested in endurance (and other) sports.

That being said, it should be noted that the present objection to neuro-doping relies on the assumption according to which the relevant interventions *circumvent*, or at least overly *reduce*, the challenge of overcoming one's mental barriers to get closer to one's physical limits. If instead, neuro-doping gave athletes just as much opportunity to face such a challenge, and merely increased the payoff for doing so (in terms of ultimate physical performance), it would no longer be vulnerable to that objection. Suppose for instance that when Mo pushes himself as hard as he can tolerate in a 10,000-meter race, he achieves an average stride length of 180 centimeters,[12] leading him to complete the race in 27 minutes. However, if he uses tDCS before the race, Mo finds it easier to perform the same feat. As a result, if he pushes himself as hard as he is psychologically capable (perhaps he manages to push hard for longer), he hits an average stride length of 185 centimeters, and completes the race in 26 minutes. His general physical ability is unchanged; rather, he is now able to realize more of his current physical potential. Insofar as, in this hypothetical example, Mo did not

[12] In this example, I am using average stride length as a rough measure of the intensity of physical work that Mo is performing. I do not claim that this is necessarily the best measure one could use in this context (or that my figures are perfectly realistic).

find it easier to produce that superior performance than his "non-enhanced" one, but simply got more "bang" for his effortful "buck" with tDCS, one might argue that his resulting achievement is no less admirable from the perspective of effort or merit – while being more impressive when it comes to his absolute performance level, and therefore more impressive overall.

The possibility of cases like Mo's also helps explain why at least some cases of *physical* doping can escape the objection from effort. For example, it is a common assumption that methods of physical doping, such as steroids, represent a corrosive shortcut that should not be allowed in sports, because they act as a substitute for effort and hard work. This assumption, however, is not accurate – at least not at the level of elite sport. While there is, for instance, evidence that someone who does not engage in any exercise might still gain a certain amount of muscle mass simply by using steroids [15], such a person will nonetheless not achieve the same results as if she had taken the same substances, and followed a rigorous weightlifting program. And there is no reason in principle why this person should end up working less hard to achieve maximum results if she took steroids, than if she didn't take any, and simply trained "naturally". If so, it seems that considerations of effort cannot ground a principled objection to the use of steroids by professional bodybuilders or other athletes (although other objections might of course be raised against the practice). Indeed, this type of consideration is distinct from the common objection to performance enhancement in sports that appeals to the purported significance of *natural* athletic performance [16]. One can consistently hold that effortfully overcoming adversity is part of what makes athletic achievements admirable, without accepting that those achievements should be accomplished "naturally", without the help of performance-enhancing devices or interventions (this reflects my own view: see [17]).

One caveat suggested by the case of physical doping with regards to Mo's case is that, in order for the latter to be immune to the objection from effort, the following crucially should *not* be the case: 1) Mo could achieve a time of 26 minutes in the 10k run *without* neuro-doping, but rather by training himself to tolerate an even higher level of strenuous effort – say, $n + 10$ "effs", to use Gwen Bradford's proposed unit for measuring the amount of effort exerted [18], rather than only n effs as in his initial 27-minute performance; and 2) 26 minutes is Mo's best possible time in the 10k race (at least based on his current physical ability), which he can either achieve without neuro-doping, by exerting $n+10$ effs, or with neuro-doping, by exerting n effs, because the prospect of completing the race under 26

minutes by combining *n*+10 effs with neuro-doping would be blocked by a physical barrier. In other words, it should not be the case that the use of neuro-doping would diminish Mo's opportunity for strenuous striving in his quest for peak performance.

The physical barriers that could in principle prevent Mo from finishing under 26 minutes by combining an even greater level of effort with neuro-doping, seem to be of three main kinds. The first one is sheer physical exhaustion, causing the body to no longer respond as effectively, if at all, to further effort. The second one is injury, once the limits of safe physical exertion get crossed. And the third one, related to the second, is the decision to pre-emptively refrain from trying even harder (even though one could), so as to avoid injury, when one senses that the risk of its occurrence has become too high. Finally, besides such physical barriers, *time* limitations might also end up curtailing an athlete's opportunity for strenuous striving if neuro-doping is used in certain contexts. Tennis again provides a relevant example here. While neuro-doping could in principle simply delay the need for such striving to a later stage in a match (as opposed to reducing or abolishing it), in practice this possibility might get thwarted, insofar as new rules, such as final set tie-breakers, are increasingly being introduced to limit the potential duration of matches at the biggest events.

The question, then, is how likely are cases of neuro-doping like Mo's original case (where the intervention does not at all reduce the scope for strenuous striving, but simply increases its payoffs) to occur in the real world, beyond the fact that they are theoretically conceivable. It certainly seems possible that they would actually represent the most likely outcome of neuro-doping, at least for the foreseeable future. If so, the argument from effort will lack real-world applicability in the near term. To ascertain this, more empirical evidence is needed about the reality of the enhancing effects of tDCS, and should these prove to be real, about tDCS's exact *modus operandi*.

For now, I will thus confine myself to the following relatively modest claim: *should* cases of neuro-doping that end up limiting the scope for strenuous striving prove a reality, the argument from effort would provide a significant reason not to allow the practice in endurance sports subject to official regulation. And it seems plausible to think that such cases are the logical end point of neuro-doping: if neuro-doping can in principle remove, or at least reduce the influence of mental barriers to top performance, and if doing so can increase the probability that one will maximize one's performance (even if, strictly speaking, neuro-

doping is not required for that purpose), some athletes will seek to use it in this way, given the challenge of pushing oneself hard day in, day out (both during training and competition).

Having laid out the objection from effort to neuro-doping, I now turn to considering three different possible retorts to it.

6. Objections and replies

6.1. Neuro-doping is no different from widely accepted enhancement methods

A first line of criticism highlights the possibility of using more conventional methods than psychoactive drugs or tDCS to lift one's inner barriers and thereby enhance athletic performance. These methods include certain mental techniques, such as acceptance and commitment therapy (ACT), which, as described by Elena Ivanova and colleagues, "teaches individuals how to accept and defuse from the unpleasant internal experiences (e.g., exercise-related pain), in turn, for a behavior that they value (i.e., physical activity)" [19]. These authors' research provides some evidence that ACT can reduce perceived effort during exercise, as well as increasing exercise enjoyment. ACT is only one example of such a mental technique among others. Furthermore, besides such techniques, familiar substances like caffeine can produce effects of a similar sort by directly acting on the brain (e.g. [6]). In fact, as the world's most consumed psychoactive drug, caffeine may simply represent an already familiar form of neuro-doping.

Very few people would object to an athlete's use of techniques like ACT to improve her performance, on the grounds that they reduce her perception of effort or enhance her motivation. On the contrary, such an athlete will likely be praised for her determination to accomplish all that she is capable of. The use of substances like caffeine for a similar purpose is also unlikely to elicit much criticism; after all, it was removed from the World Anti-Doping Agency (WADA)'s list of prohibited substances back in 2003. But then, one might ask, why should we treat psychostimulants or tDCS, which – by hypothesis – achieve the very same outcomes, any differently? Unless we can point to an ethically relevant difference between the more traditional and new types of intervention, or are willing (as few will be) to

extend the objection from effort to the former, reserving that objection for neuro-doping yields an inconsistent position, unfairly biased against "higher-tech" means of performance enhancement.

In response, we may begin by noting that the fact that ACT or caffeine might reduce the perception of effort during exercise does not necessarily mean that their impact is similar in magnitude to that (if real) of tDCS, for instance. Here again, more evidence would be needed to reliably compare the efficacy of the various methods in question. In the absence of such evidence, three possibilities are worth considering:

1. Neither traditional methods like ACT or caffeine, nor neuro-doping tools like tDCS, substantially reduce the scope for strenuous striving in endurance sports, and may not reduce it at all. (This may well be the most plausible hypothesis, based on the current evidence.) In that case, the objection we are currently considering is successful – at least with regards to existing forms of neuro-doping. While even small reductions in the scope for such striving may well, according to the line of argument we are discussing, provide a *pro tanto* reason against the relevant interventions, this reason will need to be balanced against competing considerations, including the fact that such interventions promote superior performance, and facilitate the display of certain athletic skills. If the reductions are small, and still leave plenty of room for effort to determine performance, this reason will arguably be weak enough to be outweighed by such countervailing considerations, as in the case of familiar enhancing devices like running shoes, for example [17].

2. Traditional methods like ACT or caffeine, and neuro-doping tools like tDCS, both substantially reduce the scope for strenuous striving to reach peak endurance performance (probably the least likely of all three possibilities). In that case, it would seem that, according to the reasoning outlined in section 5, we have at least a substantial *pro tanto* reason to prohibit all of those interventions. Some might argue that such a conclusion is highly implausible, and thus constitutes a *reductio* of the argument from effort. Is that indeed the case?

   In the case of mental techniques like ACT, it seems to me that a relevant difference can be identified with the other interventions, which produce their effects by directly

impacting the athlete's brain. Namely, while such mental techniques might, on the one hand, reduce the athlete's opportunity for inner struggle to approximate her physical limits, they also, on the other hand, impose a new kind of mental challenge on her, that of learning and consistently implementing the relevant techniques effectively – a challenge that will typically require some effort to be met. Direct interventions into the brain (which represent paradigmatic examples of neuro-doping), by contrast, do not seem to do so. Their use does not seem to present any particular challenge for the athlete, who remains mostly passive throughout the process, simply popping a pill (whether a prescription drug or a caffeine pill), or remaining seated for a certain period with electrodes attached to her skull.

If so, we can say that mental techniques preserve, overall, the admirable nature of athletic achievements, or at least do so to a greater extent than neuro-doping interventions, in that any diminution in the mental challenges involved in competition is compensated for, at least to some extent, by the new challenge of successfully applying those techniques. By contrast, no such compensation occurs in the case of neuro-doping – clearly a normatively relevant difference. Whether this difference is large enough to ultimately justify a difference in the regulation of mental techniques and neuro-doping interventions is again an empirical question. For techniques like ACT to differ from neuro-doping in a significant manner, it ought to be the case that the initial loss is *sufficiently*, even if not fully, compensated by the feat of overcoming the challenge presented by those techniques.

If the effective application of the techniques were not psychologically challenging enough to sufficiently compensate for the reduction in the scope for strenuous striving during competition, at least for some athletes, then the techniques would indeed become open to the objection from effort – and so will caffeine. Intuitively, however, this need not represent a *reductio* of the objection. Remember that, on the present empirical assumptions, we take both tDCS and caffeine to substantially limit the room for strenuous striving, and its relevance to peak performance. These assumptions need not be in line with the actual regulatory practices of organizations like WADA, or with people's intuitions about the appropriateness of permitting caffeine use, or ACT,

in real-world competitions.[13] The fact that the objection from effort would, under specific (although likely unrealistic) empirical assumptions, provide a significant reason for banning enhancement methods that are currently permitted, suggests that it is not fundamentally driven by "status quo bias" [20]. Its central idea is not that the current level of strenuous striving displayed by endurance athletes is necessarily ideal, but rather that allowing substantial room for such striving is an important part of what makes achievements in endurance sports worthy of admiration.

3. Traditional methods like ACT or caffeine only slightly reduce (or do not reduce at all) the scope for strenuous striving to maximize endurance performance, whereas neuro-doping tools like tDCS do so substantially. There is no conclusive evidence that this is currently the case, although it is nonetheless possible that this assumption will ultimately be proven correct, if only thanks to the development of improved forms of neuro-doping. Should this eventually happen, it seems to me that it would vindicate the objection from effort without implying that consistency would also require a change in our current practices. If only the latest neuro-doping tools turned out to substantially reduce the relevance of effort to endurance performance, this would be a possible justification for regulating them more strictly than traditional (and less effective) methods.

6.2. Neuro-doping can make athletic competition fairer

Secondly, those wishing to challenge the argument from effort might argue that there are undeserved individual inequalities in the capacity to push oneself to one's physical limits. Because of factors beyond their control, such as genetics, some people might find it psychologically more challenging than others to use the same percentage of their physical ability. And on what some might view as an appealing, "luck egalitarian" conception of fairness in sport, according to which ensuring truly fair competition requires removing

[13] Similar remarks would apply to other familiar interventions like pain medication, which could also be classified as neuro-doping. The use of such medication to alleviate pain from injury seems unproblematic, as long as it still leaves considerable room for pushing oneself through inner challenges (leaving aside the important issue of overuse in a number of sports today). However, I do think that using pain medication in ways that significantly limited the relevance of strenuous striving would be open to the objection from effort.

undeserved deviations from equal opportunity among athletes,[14] we have a powerful reason to allow those who were "unlucky" in this context (whether due to natural or other undeserved factors) to use neuro-doping, insofar as it would allow them to experience the same level of strenuousness, when soliciting the same percentage of their overall physical capacity, as the more fortunate. Assuming the latter would also benefit from neuro-doping, this would mean selectively allowing the practice rather than banning it outright: i.e. allowing only the less fortunate to engage in it, and only to the extent required to match the more fortunate. If, by contrast, further evidence revealed that only the less fortunate tended to benefit from neuro-doping, with the most fortunate hardly benefiting at all, fairness would speak against barring even the latter from using such interventions.

Whether or not any limits should be placed on the frequency or intensity of use by any athlete would depend on whether any form of neuro-doping could make pushing oneself to one's physical limits feel easier than it currently does for even the most fortunate athletes. As long as no one were lifted above that level, one might argue that permitting neuro-doping in endurance sports would not seriously diminish the relevance of effort, insofar as even the most fortunate of athletes presumably still have to overcome significant mental barriers to fulfil their physical potential. A similar argument could be defended in relation to physical doping.

While I do find this line of argument appealing in principle, it nonetheless faces significant epistemological challenges. Additional evidence concerning such supposed unfair inequalities and their origins (including any genetic underpinnings) would be needed to support it. Furthermore, the question arises as to how we would identify the "proper" level of strenuousness associated with any degree of fulfilment of one's physical ability, and whether or not any particular athletes had enhanced themselves beyond that level. At present, we would be limited to observing an athlete's behaviour during competition (looking for signs of strenuous striving), and asking her to self-report on the perceived intensity of her effort. Yet such measures would not be fully reliable, due to the possibility of both honest mistakes (people misjudging how much effort they were able to tolerate), and deliberate distortion

[14] Clearly, to be appealing, such a conception will not seek to foster equality of *outcome* in athletic competitions, which would defeat their very purpose. Its underlying assumption will presumably be that more equal opportunities will still yield unequal outcomes, partly because some relevant factors will remain beyond our control (impact of the weather, etc.), and partly because not all athletes will choose to work as hard and be equally committed, whether during training or competition.

(exaggeration of the level of perceived effort and of its behavioural manifestations) for the sake of gaining access to neuro-doping. Such challenges would need to be overcome before neuro-doping could be used to promote fairness in endurance competitions.

Moreover, the argument from fairness in favour of permitting neuro-doping within certain constraints does not seem fundamentally at odds with the argument from effort against neuro-doping, even assuming ideal epistemic circumstances. Indeed, the latter argument only postulates a significant reason to ban neuro-doping on the assumption that such interventions would substantially reduce the role of effort in athletic performance. And the argument from fairness, as formulated above, agrees that we should only permit neuro-doping to the extent that doing so would not yield such a substantial reduction. Rather than refuting the argument from effort, the argument from fairness simply adds a caveat to it: in an ideal situation in which we were able to reliably identify undeserved inequalities in the ability to push oneself to one's physical limits (not our present situation), the former argument would not justify a blanket ban on neuro-doping, but only specific prohibitions in cases (if any) where the relevance of effort to ultimate performance had been excessively diminished.

6.3. Broadening the scope of compensation

A third and final challenge would proceed from my own admission that any initial diminution in the admirable nature of athletic achievements resulting from a reduction in perceived effort, or an enhancement of motivation, might in principle be compensated for by the parallel introduction of a new challenge, and add that the possibility of such compensation is not limited to the use of mental techniques like ACT, but can actually occur in conjunction with neuro-doping. To be clear, this suggestion is distinct from the idea that the reason to prohibit neuro-doping I have sought to ground in the argument from effort might be outweighed by competing considerations, such as the possibility that neuro-doping might make sports more entertaining, or aesthetically more rewarding (think of the smooth, effortless style of athletes like Roger Federer or Usain Bolt). This latter idea, to which I shall come back in the conclusion, does not fundamentally contradict the argument from effort – rather, it only implies that while the considerations adduced by the argument do have some force, they do not conclusively support a ban on neuro-doping. The present suggestion goes further: it claims my argument overlooks additional factors that can not just outweigh my

proposed reason in favour of a prohibition on neuro-doping, but actually cancel out that reason, via a compensatory process analogous to the one I described involving ACT.

Discussing the related issue of praiseworthiness, Maslen and colleagues have thus argued that "effort is not the fundamental ground for praise for achievements" ([9], p. 3). Rather, they suggest that such grounds reside, more generally, in an athlete's voluntary and costly commitment to pursuing valuable activities. Although this does not reflect these authors' original formulation, their argument could be adapted to focus instead on what makes athletic achievements worthy of admiration. The presence of such a voluntary and costly commitment, one might argue, can be enough to preserve the admirable nature of an achievement that had been aided by neuro-doping – as long as the magnitude of the cost faced by the athlete is roughly proportional to the hypothetical reduction in mental challenges. And effort, as Maslen and colleagues point out, is only one possible type of cost among others. Alternatives include investing time or financial resources, or facing a higher risk of injury, as a result of the intervention ([9], p. 10). If so, the scope of compensation is in fact much broader than I have conceded in subsection 6.1.

In response, whatever the merits of the analysis by Maslen and colleagues when it comes to identifying what makes *athletes* praiseworthy, applying their analysis to the admirable nature, or praiseworthiness, of athletic *achievements*, on which the argument at the centre of this paper is focused, does not strike me as very plausible. Arguably, that is because the process of overcoming some difficult challenge – which mental techniques like ACT may still provide – appears necessary to properly compensate for any diminution in the perceived strenuousness of physical work underlying endurance performance. Not any "voluntary costly commitment to valuable ends" will do for that purpose. For instance, the fact that an athlete might experience undesirable health consequences from the use of neuro-doping, while certainly indicative of a costly commitment, does not seem – to me at least – to make the associated athletic achievement just as admirable as it would be otherwise. To use an extreme illustration, I would suggest that if an athlete were to use a fictional form of neuro-doping that allowed her to break the 10,000-meter world record while feeling at ease throughout the race, our sense would be that her achievement had been cheapened to some extent, and this would not change should we learn that she had later died from complications linked to the intervention, and that she had been prepared to face that immense cost.

Such a process of overcoming mental challenges thus seems required to compensate for an achievement that felt easier to accomplish, whether due to an alteration in perceived effort or motivation. Furthermore, this process must demonstrate a sufficiently close causal connection to the relevant achievement, presumably by being part of either training or competition, and must also manifest the type of athletic virtue which, among other factors, makes it appropriate to value the sport in question. Mental techniques like ACT do seem to meet those conditions. By contrast, health complications from neuro-doping are not causally required for producing the desired achievement (as the same interventions could in principle work just as well if they were fully safe), and neither are they manifestations of athletic virtue or excellence (given their origin in a mostly passive process). To take another example, spending large amounts of money to acquire cutting-edge neuro-doping technology, while involving significant cost and being causally connected to the resulting achievement, will nonetheless typically not require overcoming any inner barriers. Admittedly, it might sometimes do so: for instance, the athlete might need to overcome a strong disposition towards miserliness to bring herself to spend the money. Even if she were to do so, however, she would still not be displaying the type of *athletic* virtue relevant to her sport. Voluntary costly commitments of this kind therefore cannot play the needed compensatory role.

7. Conclusion

The main takeaway from the above discussion is that *if* any neuro-doping interventions turned out to substantially limit, among elite athletes, the relevance of effortful striving to the maximization of their physical potential (rather than, as in Mo's case, simply increasing the payoff for a given level of effort), this would give us a significant reason not to permit the use of such interventions in officially regulated endurance competitions. I am personally inclined to believe that this reason would, on the said empirical assumptions, be decisive: it is not clear to me that the loss of the relevant mental challenges (and of the displays of character excellence they make possible) would be fully outweighed, say, by the prospect of superior or "cleaner" performance. However, I do not purport to adjudicate this issue here myself. Insofar as the "spirit of sport" remains a contested matter, some might no doubt disagree with my assessment, granting greater weight to competing considerations, such as the absolute magnitude of the latest sporting achievements. Many people want to see world records shattered, and athletic performance taken to a new level. If allowing neuro-doping in

competition could help deliver those outcomes, its benefits might be judged to be worth the costs, at least by those who do not share my intuitions about the cases I have invoked from the history of sport. Ultimately, this would be a decision for the sports community as a whole (practitioners, governing bodies, as well as sports fans) to make.

I have stressed that the central argument articulated in this paper could have implications for the regulation of neuro-doping in endurance *competitions*. However, the reason against using and allowing neuro-doping that this argument is meant to support applies equally to the training context, where pushing oneself in the face of mental obstacles (especially on a consistent basis) also demonstrates excellent character on the part of an athlete. My main reason for focusing on the regulation of competitions is pragmatic in nature: a ban on the use of neuro-doping in training would seem very difficult to enforce. It is not clear, for instance, that there is any practical and reliable method of detecting the use of tDCS for neuro-doping after it has occurred [1]. Short of placing athletes under surveillance 24 hours a day, seven days a week, anti-doping agencies might thus have little power to stop the practice during training. In the context of competition, however, enforcing a ban seems more realistic, as monitoring athletes for, say, an hour or so before the start of a race (to ensure they do not apply any suspicious devices to their skulls) is a more sensible proposition. Of course, if regular use of tDCS (or other neuro-doping tools) during training turned out to produce lasting changes in brain structure that gave athletes a mental edge during competition as well, a ban limited to competition might not achieve much. However, the counterpart of this is that using tDCS right before competitions might not be particularly helpful either. Under this hypothetical scenario, use of tDCS during training would be key, and regulating the practice might simply prove impossible.

That being said, it should be emphasized that the argument from effort is premised on a specific set of empirical assumptions, one that is not currently supported by conclusive evidence. Since it is not clear so far that even the latest forms of neuro-doping can substantially reduce the relevance of effort to elite endurance performance, the argument from effort cannot at present justify a ban on the use of tDCS (or similar methods) for neuro-doping. At the level of current practice, the most that the argument can show is the need to gather further empirical evidence regarding the efficacy (or lack of it) of such tools for purposes of neuro-doping.

The present paper did not seek to reach a comprehensive verdict on the proper regulation of neuro-doping tools, but chiefly confined itself to examining considerations pertaining to the value of effort. A number of issues could be discussed further: for instance, even assuming the argument from effort to be conclusive, would a more "conciliatory" regulatory response be preferable to a ban – such as creating parallel competitions, one in which neuro-doping were allowed and another one in which it were prohibited? For now, let me reiterate in conclusion that the line of argument I have defended need not apply to types of doping (whether physical or mental) that do not remove or significantly limit the space for effortfully overcoming mental barriers to top performance. Objecting to some forms of neuro-doping based on such considerations is in principle still compatible with allowing various forms of performance enhancement in sport.[15]

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