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THE EXERCISE PILL: SHOULD WE REPLACE EXERCISE WITH PHARMACEUTICAL MEANS?

Introduction

Development within exercise science and molecular biology has increased significantly our knowledge of the physiological effects of exercise. Insights into these mechanisms opens up the possibility of manipulating and controlling them by pharmaceutical means. One idea is a pill that mimics the effects of exercise (Hoffman et al 2015; Li et al. 2015). The popular press has followed up on the idea and reports of 'a bright new future' in which exercise pills can be available.[1] The point, it seems, is to get the effects of exercise without exercising. Is this a good idea?

Journalists aside, researchers are more modest in their claims. The idea is not that a pill can be a complete substitute for exercise, but that pharmaceutical means may mimic important effects of relevance to health (Li et al. 2015). Here, however, and as a thought experiment but also as a possible future scenario, I will take as my premise the existence of a pill that mimics completely the physiological effects of exercise and is without negative side effects. Considering exercise takes time and energy and usually financial resources in addition to implying a risk for injury, the only reason for not replacing exercise with a pill must be related to values in the very activity of exercising in itself. Does exercise have such values, and if so, what are they?

Kinds of value and exercise

Examination of the concept of value and distinctions between different kinds of value is a core topic of philosophical axiology or value theory.[2] In this context I am

[1] See http://www.smithsonianmag.com/innovation/scientists-are-working-pill-just-might-replace-exercise-180956910/?no-ist

[2] For a more extensive discussion, see Schroeder (2012).

primarily interested in how values can be identified in a human practice such as exercise. Obviously, instrumental values are of relevance. Exercise has value as an instrument to goals external to the activity. For instance, research shows that regular physical activity is important in the prevention of obesity, type 2-diabetes, and cardiovascular disease (Li et al 2015). In most national and international policy documents, increased levels of exercise in the population are considered important to enhance public health.

Instrumental justifications have, however, clear limits. To avoid ending in an infinite regress of hierarchies of instrumental value, some things must be considered as valuable in themselves or for their own sake. That is, some things must have intrinsic value. In ethical theory there are several positions in this respect. In the Aristotelian tradition, philosophers point towards happiness or human flourishing or 'eudaimonia'. From a utilitarian perspective, final ends are happiness or preference-satisfaction among all parties involved, or minimization of pain. From a deontological Kantian perspective, primary concerns are respect for persons as being ends in themselves, and justice and fairness.

In an evaluation of the potential values of exercise, MacIntyre's neo-Aristotelian view of internal and external goods is of relevance (MacIntyre 2007). [3] MacIntyre contextualizes ideas of human flourishing to historical, social and cultural settings. External goods are linked to a practice 'by the accidents of social circumstances' (MacIntyre 2007: 188). In sport and exercise they typically take the form of improved fitness, or prestige of various kinds, or profit.

External goods have instrumental value. Distribution of external goods has the character of a zero sum game. The NBC TV-show 'The Biggest Loser', in 2016 in its 12th season, is a relevant illustration. This is a competition regarding weight loss with the help of an exercise and diet intervention. The winner is the participant who loses the highest percentage of his or her baseline weight. Participants compete for a fixed

[3] See MacIntyre (2007, pp 188-191) for definition of internal and external goods.

amount of money being distributed according to scores. Whatever one participant wins, other participants lose.

Internal goods on the other hand are those specifically linked to a practice and realizable only within the practice. Internal goods arise from intrinsic value. Typically, these are experiences in the execution of the abilities and skills according to specific standards of excellence in an activity. Moreover, and different from external goods, internal goods are shared with those who take part in a practice. Imagine an exercise group trying to improve fitness and health with a game of volleyball. Enhancing abilities and skills among some players increases the possibilities for enhancing abilities and skills for all.

MacIntyre's concepts of internal and external goods are centered on social practices, that is, on cooperative human activities that are socially established with a history and tradition and with socially shared standards of excellence. In the quest of realizing these standards, internal goods arise. In the realization of internal goods and shared standards of excellence, human excellence can develop in terms of more general virtues such as respect for persons, justice, courage, and honesty.[4] To the neo-Aristotelian, these are moral virtues with constitutive function in human flourishing.

[4] MacIntyre defines a social practice as follows: 'Any coherent and complex form of socially established cooperative human activity through which goods internal to that form of activity are realized in the course of trying to achieve those standards of excellence which are appropriate to, and partially definitive of that form of activity, with the result that human powers to achieve excellence, and human conceptions to the ends and goods involved, are systematically extended (MacIntyre 2007: 187). For an analysis of the relevance of MacIntyre's theory for leisure practices such as sport and exercise, see McNamee (1994).

MacIntyre's idea of external and internal goods is relevant for analyses of any form of exercise meeting the requirements of a social practice such as sporting games and probably established fitness activities such as aerobics and yoga.[5] Obviously, replacing the activities with an exercise pill means that intrinsic values and potentially morally significant values are out.

Other exercise forms, such as individual walking and jogging or strength and fitness exercises in informal social settings, are more challenging cases when considering them under the aspect of social practices. Imagine an individual who engages in solitary exercise for instrumental reasons only such as fitness, or bodily appearance according to socio-cultural ideals. Imagine, too, that exercise is experienced in negative terms. 'The reluctant exerciser' poses the challenge of what, if anything at all, is lost with replacing exercise with a pill.

A first and immediate answer is the experience of exercising itself. The follow up question is whether this experience is of value. Not being a social practice, references to internal goods and intrinsic value are premature. Still, exercise can be experienced as valuable in itself: the comfort of steady state aerobic phase, the joy of mastering a strength program, experiences of interaction with nature in outdoor recreation. In what follows, meaningful experiences of exercise will be referred to as its autotelic (from Greek autotelēs: 'goal in itself') values.

The classic example of activity with pure autotelic value is play. Theories of play point at its significance beyond and above its immediate qualities. Play is seen to have fundamental importance in development of human culture (Huizinga 1950). This is not an argument on the instrumental value of play. There is no clear causal relationship between concrete, meaningful experiences in a specific kind of play and more general values. Play can generate meaning and autotelic values at many levels in and by itself. The relationship between the various levels is interactive and

[5] For good examples of analyses of the values of sport from a neo-Aristotelian and MacIntyrean point of view, see Morgan (2006) and McNamee (2007).

mutually enforcing – it is holistic. The joy of team mastery in volleyball reflects a deeper joy of social interaction and perhaps too a joy of human sociality.

Different from intrinsic value, however, autotelic values do not carry moral significance by necessity. Joyful activities can be hedonistic and short-lived. Play can be exclusive and discriminatory but still provide meaning to those who take part. The important point is that autotelic values are meaningful experiences and that they have the potential of moral significance and value.

The critical question here is whether potential autotelic values of exercise outweigh negative experiences, resources spent, and risk of injury. If a pill can lead to the same instrumental values, why exercise? Methodologically, and to make sure that its potential is discussed in a thorough way, I will sketch three main understandings of exercise and examine if, and eventually how, autotelic value can be identified and evaluated.

The exercising body as a mechanistic system

The predominant understanding of the body in Western culture is that of an object. The body is something individuals possess – it is a tool at hand in the many activities of life. Often there is a seamless interaction between individual intention and body movement. When thirsty, I grasp the glass, lift the arm, lead the glass to the mouth and drink. A common understanding is that I determine what to do, and the body executes. Sometimes however the body emerges as both unruly and beyond my control. One example is when illness strikes. The flu attacks, the advice is to rest and 'let illness take its course'. Another typical experience of the uncontrollable body comes from sport and exercise. My intention is to hit the volleyball over the net, the result is (sadly) a net hit and loss of a point.

The understanding of the body as a means under more or less control of mind has deep historical roots and permeates in many ways Western understanding of the world. In its secular version, the idea of a distinction between mind and body, is first

found in so-called 17th Century Cartesian substance dualism.[6] Descartes distinguished between res extensa: extended substance or matter, and res cogito: thinking substance. Human beings occupy a middle position between the two substances. The body belongs to extended substance, or deterministic nature, and is subject to cause-effect laws. Mind is non-extended thinking substance and is completely independent of nature. Within thinking substance is found creativity, rationality and reflection, qualities that separate and distinguish human beings from deterministic nature.

Dualism is firmly anchored in Western languages. It should suffice to point to common distinctions between fact and value, practice and theory, and manual work and intellectual work. The terms 'physical activity' (as opposed to theoretical or intellectual activity) is a further illustration of this point.

Understanding the exercising body as a mechanistic system of chains of cause and effect-relationships has many strengths. One core task in sport medicine is the description and explanation of the optimal relation between exercise and health. The instrumental values in terms of benefits to health can be outlined in causal, mechanistic ways. The effects of exercise are quantifiable. For example, research points to that mortality risk for 'non-active' individuals is twice as high as for 'physically active' people, and that a minimum of 150 minutes of moderate intensity exercise per week is required for positive impact on cardio-respiratory functions.[7] As it is said in the global health initiative managed by the American College of Sport

[6] For an overview of dualism in its many versions and interpretations, see Robinson (2012).

[7] See ACSM's recommendations for cardio-respiratory, strength, flexibility and neuro-motor exercise on http://www.acsm.org/about-acsm/media-room/news-releases/2011/08/01/acsm-issues-new-recommendations-on-quantity-and-quality-of-exercise

Medicine (ACSM): 'Exercise is medicine'.[8]

Can the dualist understanding of the exercising body inform a discussion of autotelic values, and, more specifically, a discussion of whether an exercising pill can replace exercise? At first glance the perspective seems to have little to offer. Traditional exercise science offers no theoretical or methodological possibilities to discuss experiential values. References to the instrumental values of exercise to health provide no reason against a pill with the same effects. On the contrary, if taking time, resources and risk of injury into consideration, upon existence of a pill regular exercise seems abundant.

Dualism is exposed to criticism, among other things for the difficulties in conceptualizing embodied experience (Stricker 1970). Intuitively, there seems to be a clear contrast between anaerobic work (of short duration but high intensity) and the experience of discomfort and pain, or steady state aerobic work (of longer duration and less intensity) and experiences on comfort and mastery. Examining the values of exercise has to include investigating human experience, intention and motivation. This is also a matter of great practical relevance. National and international initiatives to raise activity levels in the population serve as examples. Overview studies point to the complexity of campaigns and the significance of situating the campaign in the psychological, social and cultural context in which people find themselves. Pointing to instrumental values is in not nearly sufficient. [9]

On the other hand, the criticism is too hard. Firstly, a distinction should be drawn between scientific epistemology and methodology, and metaphysics. Classic exercise

[8] See http://www.exerciseismedicine.org/, accessed on March 22, 2016.

[9] For an overview of the status of knowledge and the complexity of efficient and sustainable physical activity campaigns in the population, see World Health Organization http://www.who.int/dietphysicalactivity/summary-report-09.pdf?ua=1. Accessed May 27, 2016.

science builds on a working hypothesis of the human body as a mechanistic system. Hardly any scientist makes explicit metaphysical claims on this being a complete understanding of what exercise, or for that matter what a human being, is all about. Secondly, upon closer examination there are interesting findings in exercise physiology that point towards experiential qualities and autotelic value. Studies indicate that exercise releases endorphin hormones in the brain that are associated with experiences of pleasure and reduction of pain and stress (Thoren et al 1990). Endorphins associated with regular exercise are even given a role to fight depression (Balchin et al 2016). How can these findings be conceptualized and if possible translated into normative reflections on values?

The exercising body as subject and relation

One alternative is to see the exercising body not as an object but as subject.
Let me exemplify. The first hill of a run can be burdensome. The runner gasps for air, muscles balance on the verge of anaerobic energy consumption, she strives. Yet after a warm up-phase, her running flows more easily. Focus can change from experiences of discomfort towards other areas. The runner may be fascinated by pleasant scenery; a melody may cohere with her running rhythm; or she may solve intellectual problems in a brain with a surplus of oxygen. Traditional distinctions between body, mind and environment can disappear and be replaced by a unified focus or intentionality on other matters.

Phenomenology is the study of structures of consciousness with a prime focus on intentionality. A phenomenological perspective implies an understanding of human beings from a first person perspective. A phenomenological approach is directed towards the phenomena: what is immediately given to us through experience. Phenomenologists are critical to the objectifying distance, or the 'scientism', of traditional science. In a dualistic approach immediate 'lived' experience', or the life

world (Lebenswelt), is overlooked. How can a phenomenological approach be of help in exploring potential autotelic value in exercise? [10]

The example of the run provides an illustration. The discomfort of an anaerobic phase is negative. To most runners, entering a phase of aerobic steady state is experienced positively. One explanation is the secretion of endorphins in the brain, another phenomenologically inspired explanation points to experiential qualities of joy and mastery. Running can be of autotelic value. Actually, in phases of experiences of comfort and mastery, running can meet Huizinga's classic definition of play as having pure autotelic value. Maslow (1964) talks of 'peak experiences', Csikszentmihalyi (1975) points to experiences of an optimal balance between challenge and mastery with the term 'deep flow', a common reference in exercise is 'runner's high'. The experience of being a playful subject in everyday and professional life, in art, in love, or in sport, is related to experiences of authenticity and of deep meaning and value.

Based on a phenomenological understanding of exercise, what can be said of the possibility of the exercise pill? The response here is different from the dualist perspective. The interest of the phenomenologist is the experiential qualities of exercising as such. Obviously, use of a pill that makes exercise abundant implies that the experiential dimension of exercise disappears. If these experiences are meaningful, that is, if the activity has some degree of autotelic value, something is lost. Hence the pill is no replacement for exercise.[11]

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[10] For a recent collection of essays with phenomenological perspectives on sport, see Martinkova and Parry (2012).

[11] Nozick's (1974, pp. 42-45) well-known thought experiment of the experience machine is of relevance here. Imagine advanced neuro-psychologists being able to create a machine in which individuals can program the experiences they prefer and then 'plug in'. Why should they search for experiences requiring strenuous practice if the machine can provide for them without effort? Nozick's answer is that the experience machine undermines individuals as persons: as acting individuals in

Imagine the reluctant exerciser, then, and the hard case of sessions where exercise is experienced as of no autotelic value whatsoever. Here the pill seems to be the better solution. Phenomenologically speaking, however, this solution is too hasty. In Phenomenology of Perception, Merleau-Ponty (2005) offers a radical alternative to a Cartesian understanding of the body. To Merleau-Ponty, perceptions are primary for human reflection and interpretation of meaning. We are embodied subjects, we 'are' our bodies in a fundamental sense (Marcel 1979). To replace with a pill experiences of an exercising body, of fatigue, of anaerobic and aerobic states, of endorphin release in the brain, or of motor action in environments of various kinds, would be to eliminate embodied experiences of existential dimensions.

The alternative of the pill has to be reviewed with a more extensive time frame than merely one uncomfortable exercise session. Practices are valued in complex ways. In a more reflective analysis the distinction between autotelic and instrumental values breaks down (McNamee 1994). Human beings have unique capabilities of adaptation. Regular exercise leads to improvement. Autotelic value in terms of experiences of improvement and release of endorphin in steady state aerobic phases will emerge even to the reluctant exerciser. Rejecting exercise means rejecting significant experiences of being human in life world, or experiences of what is referred to as 'the humanity of movement' (Anderson 2012).

This can be contextualized further. A commonly held normative premise, originating from Aristotle, is that a flourishing life is a life in which we can explore and develop our potentials. Rawls formulates his Aristotelian principle as follows:

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control over and with responsibility for their own actions in real life. Persons are not just passive junctions of experience, they are acting subjects with intentions and insights and with responsibility for their choices and ways of life.

> …other things equal, human beings enjoy the exercise of their realized capacities (their innate or trained abilities), and this enjoyment increases the more the capacity is realized, or the greater its complexity.
>
> (Rawls 1971: 427)

A flourishing life, then, is a life where we can pursue and develop our interests and talents. Various practices contribute in various ways. The pursuit of academic knowledge adds to our capacity of reasoning and understanding. Art and literature contribute to creativity and imagination. Play and games are considered by many celebrations of human freedom. Exercise provides experiences of the possibilities and limitations of being a body.

Indeed, no human practice provides pleasure only. In science, experiences of limited resources and knowledge are common. Sometimes art and literature express lack of meaning in life. Play and games can be hard and brutal. Exercise can be uncomfortable and even painful. The point however is that the many and diverse experiential qualities of these activities provide basic insights into what it means to be human. This shows that autotelic values in exercise can be of moral significance in the larger context of human flourishing.[12]

As with the dualist perspective, a phenomenology of exercise has its limits. From an analytic, dualist perspective it may appear speculative. There are little or no 'hard data' and no identification of explanatory cause-effect relationships. The counterargument is that the critique is based on a reductive idea of research and of a lack of understanding of the complementary function of various approaches. Scientific analysis search for mechanistic explanation, phenomenological approaches

[12] An additional comment is needed. This is not an argument in support of all kinds of lived experience. For instance, no human being should suffer torture, severe hunger, or repression. These experiences are not based on an exploration of human potential but on force and of limiting and repressing human flourishing.

provide understanding of lived experience, and both are needed in a comprehensive understanding of exercise and sport (Loland 1992).

Others, in particular within social science, may consider the phenomenological perspective idealist. With their focus on the immediacy or directness of experience, phenomenologists do not extend the perspective of lived experience far enough. Typically, the analysis so far focuses on individual experience and tends to overlook social and cultural power structures that significantly shape our life-world. There is an additional perspective here that can provide further insights.

The exercising body as a social construction

The phenomenological perspective provides insight into both body subject experiences and the experience of the body as object. The example of grasping the left wrist with the right hand illustrates how we are able to shift focus, or rather, that we are able to simultaneously experience the body as an object (focusing on the left wrist) and as subject and intention (grasping).

We live both as body objects and body subjects. We can look at our bodies in a mirror with the distanced gaze of 'the other'. After a medical test we can examine physiological facts about our body. We perceive, experience and act in the world as embodied intentionality: as body subjects. The body object of science exists in objective space, the subjective body in a phenomenal space. Moving back and forth between subject and object experiences does not emerge in a vacuum but is shaped and developed in the socio-psychological and socio-cultural context of which we are parts.

Again, running can serve as the example. The runner has found a good running rhythm, she enters a steady state phase, she is no longer focused on bodily sensations. Running has the character of a holistic Gestalt in which the rhythm of the stride, the breathing, and the connection to the environment is experienced a unified whole. At a sudden moment she passes a large window and becomes aware of her

own mirror image. The perspective switches immediately towards the body as object. Her appearance is exposed to self-conscious scrutiny. The criteria for evaluation are socio-cultural norms for appearance and movement. The vain runner may be concerned with appearance according to fashion ideals. The ambitious runner looks for good movement technique; how the foot meets the surface, the lifting of the knee, the line of movement of the point of gravity.

Inspired by studies in the tradition of Norbert Elias and Michel Foucault, a sociology of the body has emerged in which understandings are sought about the body as a social construction (Cregan 2006). All known societies have more or less strict norms for function and appearance of the body. Contemporary Western mediated culture is characteristically visual. The volume and intensity of exposure to visual images and ideals of the body probably exceed any other phase of human history. The image industry, that is, the fashion business, cosmetic industries, and the fitness and health industry, is a main source of communication.

One main, perhaps subliminal, message is that of individualism. A successful individual is supposed to create him or herself and his or her life as a unique expression of self. The body is a prime object of this project. This is where feelings, intuitions, desires and pleasure are found – strong forces in human conduct that are key targets of the image industry. The body is turned into a social symbol and a means in the construction of identity.

Exercise is given key functions in this process. The physiological effects of exercise cohere with what is socially attractive: a lean, young and fit body. Almost three decades ago, Grupe (1990) pointed to the invasion of sporting and training values in popular culture. Popular culture is no less 'sporticized' today. One among many examples is the online trend of 'fitspiration' designed to inspire people towards exercise and healthy food (Tiggemann and Zaccardo 2016). Fitness and a sporty look indicates energy, mobility, vitality and initiative, which are held as important values in an individualist, market-oriented society.

These body ideals have problematic implications. To many, they imply an objectifying of the body. Acting as body-subjects are replaced by scrutinizing the body in the light of socio-cultural ideal values. Critics point to individualism as a fake value. In reality image and appearance are subdued to strict ideal norms. The image industry creates what Johansson (1998) calls 'a logic of discontent'. Individuals tend to be discontent as there are always possibilities for improvement. The industry offers remedies and technologies of assistance. The body can be changed, manipulated, rebuilt, and coloured. It is in this veig that Markula (2014) talks of the 'bio-politics of neo-liberalism'.

In such a context, life can become a constant struggle against biological processes. Surveys indicate that dissatisfaction with body appearance and weight emerges early in life (Bucchianeri et al. 2013). Sport and exercise is a risk field for development of eating disorders (Bratland-Sanda 2013). Women are more dissatisfied than men, and negative body images are associated with feelings of shame (Bailey et al 2016).

Critics warn of a situation of total bodily alienation. Impossible body ideals increase the number of customers of the image industry. Persons end in a vicious circle. Others hold a more optimistic view. The critique is one-sided. New technologies can make life easier. The cosmetic industry and new genetic technologies bring promises of liberation from biological determinism, and of the possibility to create oneself in one's own preferred image(s).[13]

The idea of the exercise pill is part of such optimism. What are the implications from the perspective of a social constructivist view of the moving body? There is a similar ambiguity here as in the general enhancement debate. On the one hand, exercise in a setting of body objectification leads to alienating processes as those discussed above. The experience of exercise is destructive and lacks meaning. Exercise

[13] For an overview of various views on enhancement within and outside of sport, see Savulescu (2007) and Murray (2007).

possesses little or no autotelic value. An exercise pill might be a way out. The pill secures the effects of exercise and training without the body objectification.

However, to a certain extent this means choosing the lesser evil. Individuals easily end up becoming dependent upon pharmaceutical products. The exercise pill can become part of a more extensive repressive 'medicalization' regime of modern society (Conrad 2007) and part of the 'logic of discontent' (Johansson 1998). This leads to a similar situation of exploitation as that driven by the image industries.

Adopting a social constructivist point of view however there are other alternative. One possibility is an exercise setting that promotes meaningful body subject experiences. Both the physiology and phenomenology of exercise indicate that access to autotelic values of exercise is for everyone. Actually, an exercise scheme focusing on autotelic values of development, joy and mastery can be a source of resistance towards the alienating force of the image industry.

In most developed countries, public policies and to an increasing degree private initiatives offer alternative exercise forms with emphasis on meaningful body subject experiences ranging from yoga and exercise to music to hiking and outdoor recreation. The current number one trend in fitness and exercise seems to be 'back to basic'- training with wearable technology (such as fitness trackers, smart watches, heart rate monitors, and GPS tracking devices) (Thompson 2016).

This might be a return to more open and socio-culturally diverse ideals of bodily appearance and function. To critics of the commercial image industry this is positive sign and strengthens the arguments against an exercise pill as a replacement of exercise.

Concluding comments

Departing from the idea of a pill providing the physiological effects of exercise, I have examined its values. My premise has been the thought experiment of a pill that

produces the complete physiological effects of exercise. The question is simply whether replacement of exercise with a pill is a good idea. Put differently, the question is whether exercise has unique autotelic values, or whether exercise is primarily of instrumental value and is replaceable by a pharmaceutical means.

To explore answers, I have examined three approaches to the understanding exercise. From a dualist point of view, exercise is understood mechanistically in terms of physiological cause and effect relationships. The approach says little of the experience of exercise and of its potential autotelic values. If a pill can mimic its physiological effects, so be it. On closer examination, however, a dualist perspective offers relevant findings such as the release of endorphin during and after exercise, which has experiential implications.

From a phenomenological point of view, exercise is understood from a first person perspective focusing on its experiential qualities. Exercise can be of negative experiential value but also offer unique autotelic values. Moreover, autotelic values are considered to be of potential moral significance as they represent an exploration of existentially significant experience of human embodiment. The idea of an exercise pill as a replacement for exercise is rejected.

From a critical social constructivist point of view, the autotelic values of exercise are questioned. It is argued that in current settings with strong emphasis on image and appearance, exercise leads to objectification and alienation of the body. Here, an exercise pill actually can be a good alternative. However, using pharmaceutical means as replacement of exercise easily becomes part of a repressive medicalization of modern life. To the social constructivist, the optimal solution is exercise settings facilitating for autotelic values and with exercise as a counterforce to alienating image ideals.

Finally, a more general insight may be drawn from this argument. Modern society includes an increasing number of bio-technologies designed and used in non-therapeutic contexts: to improve physical capabilities and appearance, to enhance

productivity at work, to perform better sexually, to combat the discomforts of aging. There seems, howecer, to be no quick fix. The would-be bio-technological enhancement changes come at a cost: the experiential qualities and potential autotelic values of working on one's potentials and dispositions as they are given to us in 'the natural lottery'. This is not a black and white-story. In some situations, bio-technological enhancement can improve quality of life, in other situations it is a result of social coercion and is destructive. Ethical reflection upon our future engagement with bio-technology is more important than ever.

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