Enhancement and Equality

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ABSTRACT. Opponents of genetic enhancement technologies often argue that the pursuit of these technologies will lead to self-defeating collective outcomes, massive social inequalities, or other forms of collective harm. They assume that these harms will outweigh individual benefits. Defenders of genetic enhancement technologies counter that individual benefits will outweigh collective harms and there will be no conflict between individual and collective interests. The present contribution tries to advance the debate by providing a more detailed discussion of the conditions under which individual and collective interests may conflict. It presents a simple model that clarifies the conditions in which the use of genetic enhancement technologies may lead to self-defeating collective outcomes and social inequalities. It argues that given current inequalities, these conditions might indeed obtain as new genetic knowledge leads to a transition in population health. If they do, then genetic enhancement will steepen the social gradient in health. Thus, regulating access to enhancement technologies should be a matter of social justice.

KEYWORDS. Genetic enhancement, equality, social gradient in health, Prisoner's Dilemma, Hawk-Dove game

I. INTRODUCTION

For most of human history, there was little difference in health and life expectancy between the ruling elites and the general population. There was no social gradient in health. From around the beginning of the 18th century, however, life expectancies in royal and ducal families in Europe increased substantially. By the early 1800s, the average age of death of the members of the English royal family surpassed the average age of death in the general population by 12.5 years. For Britain's rulers,

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the epidemiological transition took place a hundred years earlier than for their subjects.

The appearance of a social gradient in health between the elites and the general population has been explained as a *knowledge-driven health transition*.[1] New medical knowledge that had the capacity to extend lives could at first be utilized only by the richest members of society. They were the only ones who could afford oranges against scurvy, cinchona bark from Peru against malaria, ipecacuanha from Brazil against diarrhoea, or inoculation for smallpox. It took many decades before these therapies and technologies became available to the general population. Together with the public health revolution, they substantially reduced mortality; but by the time they did, the richest members of society had moved on to even greater life expectancies. Inequalities in health between the best-off and the worst-off persist to this day even in the most developed countries.

Today, we are on the verge of another knowledge-driven health transition. Genetic research promises to open up new ways to reduce morbidity and mortality. Personal genome sequencing may lead to predictive genetic tests that enable people to learn about their genetic risks and take steps to avoid or reduce these risks. Somatic cell genetic modification may lead to the development of genetic therapies for diseases that are currently fatal or the most debilitating. Genetic knowledge may also lead to a revolution in human reproduction. Prenatal gene transfer or pre-implantation genetic diagnosis followed by embryo selection can potentially be used to avoid having children with undesirable genetic mutations, to decrease susceptibility for disease, or to choose specific genetic traits. Germ-line genetic modification can potentially alter the biology of the human species, eradicating diseases and disabilities and enhancing human capacities.

Some of these technologies are commonly regarded as forms of therapy, while others have been discussed under the rubric of genetic enhancement – and for this reason have been thought to be morally problematic. But such arguments are non-starters. From the perspective of the

18th century, inoculation for smallpox or oranges against scurvy could have been regarded in much the same way as enhancements of normal human capacities as cures for common diseases.[2] In the 21st century, radically extended human life spans or greater cognitive capacities might come to be considered normal. The distinction between treatment and enhancement shifts with circumstance and time. It is hard to see why a morally unproblematic treatment at one time should be a morally problematic 'enhancement' at another time.

In the following pages, I attempt to provide a more useful approach for the moral assessment of genetic technologies. Opponents of genetic enhancement often argue that the pursuit of genetic enhancement technologies will lead to self-defeating collective outcomes, massive social inequalities, or other forms of collective harm. Such harms, they contend, will outweigh individual benefits. My aim is to map the conditions under which individual and collective interests may conflict. I begin in section II by calling attention to some facts about inequality that are underappreciated or ignored by the proponents of genetic enhancement. I argue that since the genetic knowledge-driven health transition is starting from a very unequal baseline, the worry that it will exacerbate existing inequalities is not unwarranted. It is surprising that proponents of enhancement have so far paid so little attention to this problem.

Section III turns to a more theoretical argument. This argument uses a simple game-theoretic model to show that the pursuit of some kinds of enhancement leads to self-defeating collective outcomes. The argument focuses on enhancements that target positional goods. I argue that the argument from positional goods is inconclusive – but so are the defences that are commonly given by proponents of genetic enhancement.

Section IV presents a more general model of the social consequences of genetic technologies. This model demonstrates that even if we set aside the problem of inequality in the starting positions for the genetic knowledge-driven health transition, the pursuit of enhancements can still create or exacerbate inequalities – especially when the social costs of enhancement are considerable. Moreover, even if an enhancement technology has no social costs, it is unlikely to reduce existing inequalities. It is inevitable that trade-offs have to be made between individual benefits and increased inequality or other social harms. Genetic technology is a matter of social justice. Hence, I conclude in section V with some remarks on the policy implications of my model.

Of course, some of the technologies that figure in the enhancement debate may never become reality. But surely there is no reason to think that none of them will ever become viable and our increasing genetic knowledge will not lead to a health transition. Even if the more fanciful examples of genetic enhancement prove to be ineffective or excessively risky in practice, there are plenty of possible technologies that are likely to be beneficial, effective, and free from excessive risks. As I shall argue, if and when genetic discoveries are translated into genetic technologies, the first to benefit will be the most privileged, best-off members of society – just as it was kings and dukes who first benefited from new medical knowledge during the early modern period. Human enhancement will steepen the social gradient in health. It took almost two hundred years, culminating in the public health revolution in the late 19th century, for the benefits of the first health transition to noticeably impact population health. Can we do better this time?

II. Reasons for Pessimism

Some may object that our circumstances are very different from those of the early modern period. The rate of new scientific discoveries today far surpasses the rate in any earlier period in history, and discoveries are rapidly translated into technologies and disseminated in society. While genetic technology may worsen social inequalities in the short run, on the longer term its impact will be benign. Before we know it, the genetic revolution will bring tangible benefits to all of us.

I think this argument is too optimistic. Currently, despite our medical advances, the gap in average life expectancy in the United States between urban black males and Asian-American females is over 20 years; the life expectancy gap between the best-off and the worst-off social groups is over 15 years for males and almost 13 years for females. In the United Kingdom, the gap in mortality rates between the best-off and the worst-off is greater than at any time during the last 90 years. These inequalities, however, are dwarfed by the 40-year gap in average life expectancy at birth between the least developed countries in Sub-Saharan Africa and the richest countries in the West.[3]

Even if we did not start from such an unequal baseline, accelerated technological change cannot decrease social inequalities unless the rate of the dissemination and general adoption of new technologies exceeds the rate of technological innovation. But this is unlikely to be the case. And even if it was, the problem would remain. Suppose that the marginal costs of enhancement technologies decrease sufficiently rapidly so that they are universally adopted before the *next* technology makes its appearance, and the same is true of subsequent technologies. You might think that since everyone has access to these technologies at low costs, technological change will not aggravate social inequalities. But notice that the *total* costs of adopting the technologies increase (and the greater the rate of innovation, the faster they increase), so that the worse-off are rapidly 'priced out' – unless, improbably, their real wages rise even faster.

Of course, given existing social and health inequalities, the poorest and least healthy are unlikely to be able to benefit from new technologies to begin with. In countries without publicly funded healthcare systems, genetic technologies and services will first be utilized only by those who can afford them or whose insurance plan covers them. In countries where healthcare is provided publicly, healthcare systems are under increasing financial pressure and, at least initially, are unlikely to be able to make new genetic technologies and services available to everyone. Those who can afford them will purchase them on the market. Meanwhile, the vast majority of humanity, living in developing countries, will be unable to benefit at all from our new genetic knowledge.

Even if these factors are set aside, there might be other reasons for persisting or increasing inequalities in the presence of safe and effective genetic technologies. It would not be the first time in history that strong social norms impeded the adoption of beneficial technologies. The early adopters are likely to be members of the elite who can afford both to buy them and to avoid social sanctions.

This new health transition might also change the *pattern* of health inequalities. In the 18^{th} century, the number of people who could benefit from new medical knowledge was tiny compared to the general population. There was little inequality in health between most members of society, with the exception of a small aristocratic elite. In the 21^{st} century, the pattern of health inequalities might be different: there could be a health gap that is deeper than ever before between two large groups, one of which has substantially better health and higher well-being than the other. An inequality that obtains between two large groups can be considered worse than the same inequality that obtains between a tiny group and the rest of society.[4]

Why are the facts about current and future health inequalities not better appreciated by the defenders of genetic enhancement? One reason might be that much of the debate on genetic enhancement has focused on reproduction. In this context, the central issues are thought to be the extent to which the state may interfere with reproductive autonomy either to prohibit or to promote genetic choice, and the kind of obligations prospective parents may have in reproductive choices. Social consequences, when they are addressed at all, are discussed only insofar as they affect individual choice.

In other words, questions of distributive justice have been peripheral in the enhancement debate. For instance, Julian Savulescu, a prominent defender of genetic enhancement, says simply that it is not inevitable that genetic technologies will lead to more inequality – it is up to us to use them responsibly (2009, 185). As I shall illustrate below, the issues are far more complicated than this. Peter Singer, another supporter, argues that even if a country decided to ban genetic enhancements, the ban would not be effective because people seeking enhancement would travel to other countries without such bans in place (2009). While it is probably true, this is beside the point. Even if a ban would be ineffective, it does not follow that enhancement is morally unproblematic.

III. Is Genetic Enhancement Collectively Self-Defeating?

There is, however, one argument about the social consequences of enhancement that has figured prominently in the debate. It is, in a way, a counterpart to the 'optimistic argument'. According to this argument, enhancement technologies, at least when used for obtaining goods of a certain kind, will indeed inexorably lead to social harms; moreover, unless these uses are limited, we will be powerless to reduce the harms. In these cases, the pursuit of enhancements will be collectively self-defeating.

The goods in this argument are *positional goods* – goods that confer an advantage only if others have less of them. The value of such goods partly depends on their distribution in the population. One example is height. Taller people are more successful on the job market and they earn higher than average incomes. Taller men are more likely to be married than their shorter-than-average peers. But the advantages that height confers depend on the presence of shorter people. If height-enhancement technology is provided to everyone, the advantages disappear. Positional goods are inherently scarce.

To illustrate the argument from positional goods, suppose a prenatal gene therapy becomes available for creating children who grow up to be taller than average.[5] Those parents who first have access to the therapy can ensure that their children have competitive advantages later in life. Realizing that these advantages depend on the scarcity of the technology, they will have an incentive to try to restrict the access of others to the therapy.

Suppose they do not succeed, however, and all parents use the therapy in the hope of conferring advantages on their children. But if all of them do this, everyone in the next generation is going to be tall and the parents confer no benefits on their children. In the absence of shorter peers, height has no advantages. All the parents (or their insurance plans) pay for the costs of a therapy without any benefits. Inequalities due to other factors remain intact while society has wasted resources.[6]

One objection to this scenario might be that as parents realize the social consequences of enhancing their children's height, they would stop using this therapy. But the cost they incurred to secure a competitive advantage has now become the cost of avoiding a competitive *disadvantage*: if some parents do not use the therapy, their shorter children will have worse life prospects. If the disadvantages are sufficiently great, parents cannot afford not to use height-enhancement. Hence all parents will continue to use the therapy in order to avoid a disadvantage without securing any further advantage. They participate in a socially harmful arms race.

The predicament of the parents is often presented as a many person Prisoner's Dilemma. It is illustrated in Figure 1. For the sake of simplicity, the figure only shows the choices of two couples. The payoff numbers represent the ranking of the outcomes, determined by the benefits and the costs *together* for the parents and the children whose adult height can be altered by enhancement. Thus, I am ignoring the fact that the costs are likely to fall on the parents and the benefits on the children. I am also ignoring the fact that the costs must be borne by the parents now, while the benefits would be enjoyed by the next generation. For the purposes of the argument, these complications can be set aside.

	Refrain	*Enhance*
Refrain	1, 1	–1, 2
Enhance	2, –1	0, 0

Figure 1.

The rows and the columns represent the alternatives parents can choose from – whether to use enhancement technology (*Enhance*) or not (*Refrain*). The first number in the cells is the payoff for the parents whose alternatives are represented by the rows, and the second number is the payoff for the parents whose alternatives are represented by the columns. Greater numbers represent better outcomes.

Consider the situation from the perspective of the parents whose alternatives are represented by the rows. The best outcome for them is if they themselves use the technology (choose *Enhance*), but the other parents, whose alternatives are represented by the columns, do not. In this case, these parents confer all the benefits on their taller child while other people's children bear the disadvantages.[7] At the same time, if the 'column parents' also choose to enhance, they can avoid their worst outcome – having a child who has all the disadvantages of being shorter. Given the payoff structure, enhancement is a *dominant strategy* – no matter what other parents do, each couple is better-off by choosing enhancement. Since all parents are in a symmetrical situation, all will choose enhancement.

It is easy to see where the problem lies. Everyone would be better off if no one chose to enhance. They all pay the costs for a technology that brings no benefits. But they cannot reach that outcome. They end up with (0, 0), rather than staying at (1, 1). Enhancement, therefore, is collectively self-defeating.

So as a society, we had better find ways to avoid an enhancement arms race. The most straightforward way to 'solve' (more precisely, to avoid) a Prisoner's Dilemma-type situation is to change the payoff structure by banning certain alternatives. In this case, that could be achieved by prohibiting enhancement.[8]

The problem is not merely that enhancements targeting positional goods bring no benefits. They also make inequalities worse. For even if the better-off and the worse-off pay the same costs to keep up in this arms race, the worse-off will end up even worse-off: although they have to put the same amount of resources to non-productive use, these resources are more valuable to them. Their loss harms them more than the loss of the better-off harms the better-off. The resources the worse-off have to expend on the enhancement arms race have higher opportunity costs. In a more precise illustration, parents would not be in an identical situation, since an enhancement arms race would harm some more than others. But enhancement would remain the dominant strategy.

How realistic is the problem of an enhancement arms race? The answer, at least in part, depends on the kind of traits enhancement technologies would target. Are the goods associated with these traits positional?

Consider some examples. Decreased susceptibility to disease, increased disease resistance and greater life expectancy are benefits that are unlikely to have positional aspects, although increased longevity will have an impact on population size that aggravates the scarcity of health care resources.[9] Height, athletic ability and other competitive talents, on the other hand, have a positional aspect. They are more likely to lead to enhancement arms races.

Defenders of genetic enhancement usually give three kinds of reply to the argument from positional goods. First, they often point out that there are also environmental means to secure such goods. Parents can send their children to expensive private schools and pay for extra classes or athletic activities. They can provide healthy food and safe environments for their children. In the competition for positional goods, the better-off are already in an advantageous situation, except that currently they use environmental rather than genetic means to give their children a better start in life. We do not prohibit the uses of these means – and often we encourage them. Thus, in the presence of safe and effective genetic enhancement technologies, the distinction between environmental and genetic means is morally arbitrary. When it comes to relevantly similar environmental and genetic means of enhancement, either we should permit or prohibit the use of both. There is no reason to permit the use of enhancement – for instance, for higher intelligence – by environmental means, but prohibit enhancement of intelligence by genetic means.[10]

This argument makes a valid point, but it is inconclusive. If we are concerned with social inequalities, we can agree that the distinction between environmental and genetic means of enhancement is morally arbitrary, yet maintain that we have good reason to prohibit some means of enhancement to prevent existing inequalities from increasing further. The morally relevant distinction is not between genetic and environmental means, but between those means that substantially increase inequalities without counterbalancing social benefits, and those that do not. As I have argued, genetic knowledge can potentially lead to a health transition whose benefits will be very unequally distributed. We have reason to be concerned with the social impact of this knowledge.

A second kind of reply to the argument from positional goods points out that goods like intelligence (perhaps the most frequently discussed possible target of genetic enhancement) are not purely positional. Since they also provide benefits in absolute (rather than purely relative) terms, their enhancement is defensible. Often, the argument ends here.[11] Plainly, this reply is insufficient. Enhancement may be collectively self-defeating even if its good is not purely positional. It must be shown that its benefits outweigh its harms.

A more sophisticated version of this reply appeals to the possible positive external effects of enhancement technologies. A good, for instance, may have *network effects*: its value increases as more people have it. Allen Buchanan argues that many enhancement technologies will exhibit network effects: the more people use them, the more valuable they are for everyone (2008). For instance, even though intelligence might have a positional aspect, it also has a 'network aspect': large numbers of people with enhanced intelligence would be able to accomplish tasks that either a few people with enhanced intelligence or a large number of people without cognitive enhancement could not. The argument from positional goods overlooks the fact that many goods that could be provided by genetic enhancement have not only positional aspects, but they are also characterized by network effects and other positive externalities.

Even those who do not have access to enhancement technologies may benefit from others having enhancements.

I think Buchanan is right to point out that genetic enhancement technologies may generate positive externalities. But it is also possible that the positional aspect of a good 'crowds out' its network effects, so that pursuing it remains collectively self-defeating. What matters is whether the social harms due to the negative external effects of a good outweigh its benefits. This is an empirical question that cannot be settled in advance, especially if the characteristics of the technology are not yet known. Therefore this reply is inconclusive too.

Moreover, even if positive externalities are present, there is likely to be a time lag between the introduction of an enhancement technology and its general adoption in the population. If the genetic knowledge-driven health transition takes a long time, inequalities in the meantime are likely to get worse, and by the time a technology is available to all, the better-off are likely to have access to even more advanced technologies. Even positive external effects do not guarantee that social inequalities are not aggravated.

A third kind of reply is to retreat to a more cautious position on the prospects of genetic technology. At least in the short run, the most likely targets of genetic enhancement are going to be goods associated with health. The first applications of our increasing understanding of genetics are likely to aim to reduce susceptibility to disease, eradicate congenital disabilities, increase disease resistance, and extend life expectancy. These health benefits are the least likely to have positional aspects and the most likely to have positive external effects. They are, for the most part, unambiguous benefits both from the individual and the social perspective.

In summary, the argument from positional goods is not conclusive. On the one hand, defenders of genetic enhancement have a point when they argue that the most beneficial and realistic applications of genetic technology need not have collectively self-defeating consequences. On the other hand, their arguments do not alleviate the worries about other social harms of enhancement.

IV. Enhancement Hawks and Enhancement Doves

It is not unreasonable to worry that the genetic knowledge-driven health transition is going to widen the health gap between the better-off and the worse off. Even if not only kings and dukes are likely to benefit from genetic knowledge, many people will be unable to access new genetic technologies and services. Disadvantages in health have a huge impact on broader social disadvantages. Thus, social inequalities are likely to get worse.

Defenders of genetic enhancement sometimes deal with the objection from inequality by taking a particular position on the value of equality. They admit that genetic enhancements are likely to be available at first only to the better-off and they will increase the social gradient of health. But they point out that as long as the worse-off are not harmed by the increased inequalities, there is no moral reason to restrict the availability of genetic technology to the better-off. A ban would merely leave the better-off worse-off without benefiting anyone else. It would be a form of *levelling down*. Defenders of enhancement might argue that there can be nothing good about achieving greater equality by levelling down. Since a ban on genetic enhancement does not benefit anyone, there is no good reason to introduce it.[12]

This argument assumes that equality has value only if it benefits people – only if there are people for whom greater equality is better. On this assumption, given that you cannot improve the situation of the worse-off, there need not be anything wrong with increasing inequality by improving the situation of the better-off. Indeed, it may be wrong not to do so.

We do not have to take a stand on whether achieving a more equal outcome by levelling down is wrong. If there are circumstances in which it is not, then there is a further moral consideration – that enhancement exacerbates inequality, even if it would make no one worse-off – that has to be taken into account in evaluating the social consequences of genetic technology. But even those who reject levelling down have a reason to take into account inequality, because it is very likely that genetic enhancement will harm the worse-off through increasing inequalities. A steeper social gradient in health makes the worse-off even worse-off.

To illustrate this we might consider positional goods again. While health may have little or no positional aspect, it has an important role in determining success in the competition for positional and other goods. People in worse health have a disadvantage in the competition for desirable jobs, positions, or other advantages. Worse health diminishes your opportunities and makes it more difficult to take advantage of the opportunities that you do have. I have argued that the goods of genetic enhancement, at least initially, are going to be health benefits: genetic tests and therapies to reduce morbidity and mortality, the eradication of disability, or genetic modification to increase healthy life expectancy. If not everyone can utilize the new genetic knowledge, those who are left out will have a smaller range of opportunities and will be less likely to compete successfully for social advantages. So the problem is not that enhancements will target positional goods, but that many of the goods that enhancements will target have an impact on people's chances in the competition for positional goods and other advantages.

In other words, maintaining health has a fundamental role in protecting opportunities, and maintaining equal health has a fundamental role in protecting equal opportunities. But genetic technology creates differences between different social groups with respect to the level of health they can achieve, and it makes it easier to maintain the health of those who have access to it. Thus, differences in health lead to differences in opportunity, which in turn lead to social inequality. These inequalities directly harm those who do not have access to genetic enhancement.[13]

So far, I have argued that genetic enhancement will lead to more inequality both because of our unequal starting positions in the genetic knowledge-driven health transition, and also because of its negative impact on equality of opportunity. I will now argue that even if we set these aside, it can be shown that enhancement may exacerbate inequalities.

I claimed that the argument from positional goods is inconclusive. But the harmful social consequences of genetic enhancement need not take the form of 'enhancement arms races'. The Prisoner's Dilemma can serve as a model for only part of the problem. It misses the importance of increasing social inequalities. A better model is provided by another simple game, known as *Hawk-Dove*. Figure 2. is a general version of the said game.[14]

	Refrain	*Enhance*
Refrain	$\frac{1}{2}, \frac{1}{2}$	0, 1
Enhance	1, 0	$\frac{1}{2}(1 - c), \frac{1}{2}(1 - c)$

Figure 2.

For interpreting this model, I assume that the costs and the benefits of enhancement fall on individuals. I also assume, for the moment, that society consists of only two individuals. Both of them are faced with the choice of whether they should use an enhancement technology that brings health benefits but also has costs. If an individual uses enhancement but his or her opponent does not, he or she will enjoy the benefits and the social advantages of being enhanced – including putting his or her opponent at a disadvantage. In this example, the payoff for the individual who uses enhancement is 1, while his or her opponent gets 0. If neither individual uses enhancement, they both end up with a payoff of $\frac{1}{2}$. Finally, if they both choose to enhance, then the payoffs are determined by the parameter c. This parameter represents the social costs of enhancement.[15]

The social costs can be caused by any sort of negative external effect to which the widespread adoption of genetic enhancements might lead. They might be caused by increased competition for positional goods. They might represent the erosion of social solidarity and compassion as people are expected to take responsibility for their genetic risks. They might represent the erosion of tolerance for diversity. Or they might represent the loss of our 'egalitarian ethos'. The costs might also come from detrimental effects on our 'collective consciousness', or from changing attitudes toward reproduction and parenting. I do not insist that any of these will happen; what I am interested in is merely their social consequences, if they happen.[16]

Suppose first that $c > 1$. The social costs of enhancement arising from negative externalities are considerable. If $c = 2$, both individuals have a payoff of $-\frac{1}{2}$ if they both choose enhancement. Given this, each prefers to enhance if his or her opponent refrains from enhancement, and each prefers to refrain from enhancement if his or her opponent engages in enhancement. That is, the outcome of this interaction will be (1, 0) or (0, 1). The outcome is going to be unequal, even though initially both individuals were in an equal situation. Enhancement with high social costs creates inequality.

In other words, if enhancement technologies have considerable negative external effects, then individuals will want to use them only if they can avoid these negative effects. Otherwise, the social costs of enhancement would fall directly on them, and given that everyone chooses to enhance, the costs outweigh the benefits. In a case like this, some sort of convention or implicit agreement might arise that determines which individual uses enhancement and which 'yields' in order to avoid its harms. Now if we drop the assumption that individuals are in a symmetrical situation, it is not implausible to hold that existing differences in power, social situation or advantage will determine which individual that is. The socially advantaged are more likely to become 'hawks' and the socially disadvantaged are more likely to become 'doves'. Those who are better-off can risk enhancement even in the face of possible harms and have ways to ensure that they will be the ones who reap the benefits. The worse-off, by contrast, have to forgo enhancement even if they thereby acquiesce to even greater social inequalities. The important point to notice is that when genetic enhancement has high social costs, it need not be collectively self-defeating. Rather, it can result in increased social inequalities.

Let us also drop the assumption that there are only two individuals in society. We can interpret the rows and the columns as each representing half of the population. For simplicity, suppose that individuals are paired off to 'play' a Hawk-Dove game against one another. In this case, it is rational for each individual to choose to refrain with probability $(1 - 1/c)$ and to enhance with probability $1/c$. So, if $c = 2$, then half of the population will use enhancement and the other half will not. As the social costs become even greater than this, a smaller and smaller fraction of society will use enhancement. A smaller elite will be enhanced, while the larger part of society does not benefit from genetic technology. Once again, enhancement is not self-defeating, but inequality-aggravating.

As the costs fall toward 1, more and more people will use enhancement technology. When $c \leq 1$, everyone will prefer enhancement. But now a different problem arises. When $0 < c < 1$, enhancement is the dominant strategy, even though everyone ends up worse-off than foregoing enhancement altogether. The situation becomes the Prisoner's Dilemma that we considered above. In such cases, enhancement is collectively self-defeating.[17]

Enhancement will lead to optimal outcomes only if it has no net social costs at all – if it causes no negative external effects or if its social benefits through network effects or other positive externalities outweigh its harms. In this case, the game is transformed. It is not a Hawk-Dove game any more, hence the above reasoning does not apply. For instance, if $c = -1$, everyone benefits from enhancement, all receiving a payoff of 1. In this case, there is no reason to restrict access to genetic technology.

In my illustration, individuals started from a symmetrical position. There were no initial inequalities. In reality, however, we will begin the genetic knowledge-driven health transition from unequal starting positions. If enhancement is socially harmful, it might still be pursued by some members of society for their individual benefit, exacerbating inequalities in the process. But even if enhancement has benefits for all and it is universally adopted, it cannot by itself reduce inequalities. It will not flatten the social gradient in health. This is true even if the goods that enhancement targets have no positional aspects.

V. Policy Implications

What are the policy implications of this model? Its main lesson is that the regulation of genetic enhancement technologies is a more complex issue than it initially appears. There is a range of policies that can be reasonable, depending on the social harms and benefits of particular technologies. In this essay, my main concern has been with inequality; but I did not speculate on the kinds of negative externalities that might contribute to increasing inequalities. Instead, I was interested in the circumstances in which externalities might have a negative impact. Despite this limitation, some general conclusions can be drawn.

When the introduction of an enhancement technology would have substantial social costs, there may be a reason to limit access to it. Even though it is apparent that the technology will cause social harms, those who are more advantaged can minimize or avoid the harms for themselves. They enjoy the individual benefits of the technology while others have to forgo these benefits in order to avoid the harms. The more advantaged engage in a form of 'free riding' on the restraint of others.

In other cases, genetic enhancement is likely to have both individual and social benefits. Even if only a part of the population has access to a technology, it may have positive external effects that benefit everyone. But even with these benefits, enhancement may maintain or aggravate social inequalities and work against equality of opportunity. The most advantaged members of society will be the first to undergo the genetic knowledge-driven health transition. Even with the rapid spread and falling costs of enhancement technology, the social gradient in health is likely to steepen or remain intact. As I have argued, this in turn exacerbates other kinds of social inequalities and aggravates inequality of opportunity.

Nevertheless, limiting access to genetic enhancement may not always be the optimal policy response. On the one hand, if a technology has substantial individual benefits, even though it cannot be provided to everyone, it might be reasonable to trade off equality for these benefits.

Currently, not everyone who needs an organ can be provided one. Still, most people would agree that it would be bad policy to deny organs to some because they cannot be provided to all. In this case, there is no reason to insist on greater equality of outcome.

Perhaps a more desirable policy approach is not to limit, but to extend access – even if this means accepting social harms for the sake of more equality. Society can tolerate some negative externalities in exchange for less inequality. This could, for instance, be done through the public health system. Predictive genetic tests could be made available to all so that people can avoid or minimize their genetic risks. Prenatal gene transfer and germ-line genetic modification could be provided as a part of maternal health programmes to decrease susceptibility for disease, to eradicate hereditary or congenital disabilities, to strengthen the immune system or to extend the life span.

Given the existing disparities in health both in the developed and the developing world, the provision of enhancement technologies within the public health system would have a number of advantages. If new technologies are provided publicly, increased demand might spur innovation and drive down marginal costs. Genetic enhancement can be provided more cost-effectively to those who are at the bottom of the social gradient. Because of their worse starting position, they have a greater capacity to benefit from therapies and interventions that reduce their genetic risks, extend their lives or improve their health.

Under resource constraints, publicly funded healthcare systems would be able to afford only the most cost-effective enhancement technologies. The newest and most expensive technologies will be available only to the better-off at first. But, given that the costs of these new technologies decrease with time, it might be best, all things considered, to allow unequal access at first and provide the technology publicly when it is affordable within the public health system.

Such policies are likely to be costly. But if our aim is to minimize the inequalities that the genetic knowledge-driven health transition will lead to, we need to provide genetic enhancement to less advantaged members of society. It took many decades for the first knowledge-driven health transition to impact the health of the whole population. In order to minimize this time lag, regulating access to genetic enhancement technology should be a matter of social justice.

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Notes

1. For details, see Johansson (2010).

2. Scurvy, for instance, usually killed half of the crew on any long sea voyage.

3. The size of both intra-national and international discrepancies remains comparable if you consider the distribution of the burden of disease, taking into account non-fatal health outcomes in addition to premature mortality. For the US data, see Murray *et al.* (2006); for the UK data, see Thomas *et al.* (2010); and for international data, see Lopez *et al.* (2006).

4. See Temkin (1993) for an analysis of the badness of different patterns of inequality.

5. Synthetic growth hormone therapy is already available to children with growth hormone deficiency.

6. And when a newer height-enhancement technology becomes available, parents face the same predicament again and the cycle is repeated.

7. This outcome is represented by the lower-left cell with payoffs (2, –1).

8. For a more detailed presentation of this argument, see Kavka (1994).

9. Brighouse and Swift (2006), however, point out that health does have competitive value insofar as healthier people are more likely to compete successfully for positions and other advantages. I will return to this issue below.

10. For this argument, see, for example, Wilkinson (2010, 203-204). For a fuller discussion of environmental and genetic means of enhancement, see Buchanan *et al.* (2000).

11. See, for instance, Harris (2007), Bostrom and Sandberg (2009) or Singer (2009).

12. For the levelling down objection, see Parfit (2001). See also Farrelly (2004) for an application of the levelling down objection in the context of genetic enhancement.

13. For a more detailed version of the argument from equality of opportunity, see Mehlman and Botkin (1998). The role of health in protecting equal opportunity is a central element in Norman Daniels' account of justice in health (2008).

14. The name comes from the story of two predators fighting over a prey. The game is also known as 'chicken'. In that version of the story, two drivers are on a collision course; if neither swerves, both will die, but if one swerves, he or she proves himself a coward.

15. Here I am assuming that the social costs emerge only when enhancement is chosen by both individuals – that is, when it is universally adopted. This assumption is actually extremely optimistic. More realistically, social harms would either appear above a threshold fraction of adopters in the population or the harms would increase as more and more people choose enhancement. The second interpretation of the model, which I will introduce in a moment, allows for the latter possibility.

16. Opponents of enhancement have discussed different forms of social harms. For instance, social harms from altered reproductive attitudes are discussed by Michael Sandel (2007). Gregory Kavka (1994) enumerates possible harms for our collective consciousness. Dov Fox (2007) worries about the erosion of the egalitarian ethos. For further discussion, see also Brock (2005).

17. If $c = 1$, the payoffs in the lower right cell are (0, 0). Since no individual is worse-off no matter what others do, enhancement is a *weakly dominant* strategy. But this outcome is sub-optimal: if no one chose enhancement, everyone would end up better-off. So far I have been assuming that $c > 0$. If enhancement has social costs, the reasoning in the main text does not apply. If $c = 0$, the payoffs in the lower right cell are ($\frac{1}{2}$, $\frac{1}{2}$). Enhancement is a *strictly dominant* strategy: all individuals are better-off by choosing it, no matter what others do. But this outcome is not better for anyone than foregoing enhancement. In this case, enhancement has no benefits at all.