Creating Future People

The Science and Ethics of Genetic Enhancement

SECOND EDITION

Jonathan Anomaly

ROUTLEDGE

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Routledge
Taylor & Francis Group
NEW YORK AND LONDON

Designed cover image: © Getty

Second edition published 2024
by Routledge
605 Third Avenue, New York, NY 10158

and by Routledge
4 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

Routledge is an imprint of the Taylor & Francis Group, an informa business

First edition published by Routledge 2020

ISBN: 9781032734514 (hbk)
ISBN: 9781032636573 (pbk)
ISBN: 9781003464266 (ebk)

DOI: 10.4324/9781003464266

Typeset in Joanna
by codeMantra

Preface

We all want future people to flourish. We want our children to be healthy and happy, and we want them to live meaningful lives.

Over the past few centuries we've remade our environment by altering ecosystems and modifying crops. We've changed how our children think with compulsory education. We've altered their immune systems with vaccines and antibiotics. Apart from environmental interventions to improve our children's prospects, should we *genetically* modify our children?

New forms of biomedical technology will soon enable parents to exercise more direct control over the traits of their children. Pre-implantation genetic testing (PGT) already allows us to screen embryos in order to reduce the risk of monogenic diseases, such as cystic fibrosis and Tay Sachs, as well as some polygenic diseases, such as diabetes and breast cancer. But soon, parents will be able to select embryos for mental traits like intelligence, aesthetic traits like height and eye color, and personality traits like conscientiousness.

How does PGT work? When women go through IVF, they typically generate more eggs than they need, especially if they are young and fertile. When eggs and sperm are combined to create embryos, the embryos are genetically sequenced, and statistical models allow us to assign each embryo a polygenic risk score, which indicates the likelihood that they will

develop traits ranging from brown hair to diabetes. Polygenic scores are created from genome-wide association studies (GWAS). GWAS consist in genotyping large numbers of people (by giving them a genetic test) and phenotyping them (by gauging their physical and psychological traits). These traits can then be 'associated' – or correlated – with specific genetic variants.[1] With enough people and enough associations, scores can be assigned to each embryo quantifying the likelihood that it will develop specific traits if it is implanted and becomes a person.

Some have argued that we can't know whether polygenic predictions work until an embryo reaches adulthood. But this is wrong. If polygenic scores have predictive validity, they should not only be able to predict the traits that an embryo will eventually develop if it is implanted; they should also be able to predict the traits that existing siblings have. After all, brothers and sisters are genetically related in the same way embryos in a petri dish are: they share the same parents and have the same amount of kinship. The question is not whether polygenic scores work, but how well they work. This depends on the trait in question, and the quality of data for the ethnic group parents belong to.[2]

It is important to stress that polygenic scores are probabilistic. This is because the traits polygenic scores predict sometimes emerge from the interaction of hundreds or thousands of single-nucleotide polymorphisms (or SNPs, pronounced 'snips'), and we do not yet know the effect of every SNP. Many SNPs are 'additive', meaning that each of them contributes just a little bit to a trait like height. But some SNPs are rare genetic variants that have larger effects than normal SNPs, and thus contribute more dramatically to a trait. For example, while many genes influence the probability that a woman will

develop breast or ovarian cancer, the BRCA 1 and BRCA 2 genes alone account for nearly 3% of all breast cancers and 10% of all ovarian cancers.

So far, embryo selection is limited by the still young science of genetics, and the small number of eggs women can generate through induced ovulation. But there are two reasons this will change quickly. First, machine learning is accelerating our understanding of what genes do, and how they interact to shape traits. Second, a newly discovered technique allows us to take any somatic cell – such as a blood cell – and turn it into a pluripotent stem cell from which we can create eggs.[3] This will allow us to generate a large number of embryos from which to choose before deciding which to implant. After all, men make millions of sperm every day, but women create relatively few eggs, especially as they get older.

In vitro gametogenesis – the process of transforming adult cells into eggs – will dramatically change the way we reproduce. It will mean women no longer need to go through IVF in order to select embryos. And it will increase the variation of traits from which they can select by increasing the number of embryos, each of which represents a unique combination of parental genes. Selecting a spouse (or a sperm or egg donor) will determine which genetic combinations are possible. But more eggs means more embryos and thus more genetic variation from which to select. This is why IVG will be a transformative technology.

Apart from selecting embryos based on their genetic profile, gene editing tools like CRISPR may allow us to delete novel mutations – most of which are harmful – that occur during a normal human lifetime, and which can be passed along to our children. At some point, many of us will be able

to use a combination of PGT, gene editing, and other techniques to sculpt the traits of our kids.

Visionary biologists like Craig Venter and George Church go even farther: they envision a more distant future in which we can create children from scratch by writing a genetic code and constructing a synthetic genome from common amino acids. The moral and political questions raised by these technologies are as profound as any our species has ever faced. The risks are grave, and the possible benefits are enormous.

Each chapter in this book will advance arguments for enhancing traits that might benefit future people. This book will cover some of the mainstream debates on genetic enhancement, but will often focus more on issues neglected in the debate so far, including collective action problems in which the reproductive choices of each affect the welfare of all. For example, imagine that each child would benefit from an enhancement that confers immunity to a disease like tuberculosis that threatens the current population, but also that all of us would be better off with more immuno-diversity in the population. Will parents left alone to make choices for their own private reasons solve the problem? Will new laws or norms be needed to coordinate our actions? What are the moral advantages of relying on free choice in comparison with different kinds of restrictions?

Similar questions arise for enhancing cognitive traits like empathy, self-control, and extraversion – all of which are strongly influenced by genes. In a world in which the genetic endowment of our children does so much to influence their prospects, it is likely that black markets for genetic enhancements will thrive, even if governments attempt to restrict them. This fact will influence the feasibility of regulating the market for technologies that allow us to select and alter embryos.

Contemporary philosophy thrives on technical terms and carefully crafted distinctions. This is supposed to help us navigate a tangle of complicated moral intuitions, and turn them into more tractable principles and theories.

As is customary in applied ethics, I skirt many of the difficult theoretical issues moral philosophers spend their time on, and instead rely on a simple and plausible way of making moral arguments. I appeal to *reasons*. As philosophers understand them, *moral* reasons are simply considerations in favor of acting in a certain way. In contrast, *epistemic* reasons are considerations in favor of believing a proposition. For example, I have a moral reason to treat vulnerable people with compassion rather than hostility, and an epistemic reason to believe that rainbows are made of refracted light rather than fairy dust.

When moral reasons come into conflict with each other, or with epistemic reasons, we cannot escape making value judgments to adjudicate the conflict. For example, when embryo screening is available, people will have to choose whether or not to use it, and then choose which traits to prioritize, given that every embryo has a unique genetic endowment with a particular risk profile. Parents may decide to sacrifice an aesthetic trait that they value, such as height, so that they can select an embryo with a greater potential for intelligence or conscientiousness – not because shorter people are smarter or nicer, but because in this example, the embryo with less height just happens to have a higher score for IQ and conscientiousness. Most embryos (like most people) are a mixture of traits that are likely to make a life go better or worse, as judged by particular people. And this means parents will be making value judgments, whether or not they are explicitly aware of

it. Some parents may wish to make themselves deliberately ignorant of a trait – for example, of whether the embryo they implant is a boy or a girl. Perhaps they think it is wrong to know these things, or they simply like surprises. This is a case of sacrificing an epistemic reason to seek the truth for a moral or practical reason to deliberately avoid information.

Although there are real differences in our moral commitments, there is often a surprising amount of agreement about which values are at stake. For example, most people place at least *some* value on individual liberty, on fair rules and procedures, and on the welfare of current and future people. And most care about truth, even if they think some illusions are worth preserving. But they differ in how much weight to assign to values like liberty and fairness, and how to interpret those values in the context of a particular choice.

THE GAME PLAN

The goal of each chapter is to give an overview of the relevant science, to give reasons for and against specific kinds of enhancements, and to explain when access to enhancement technology might generate collective action problems. In this sense, I hope to raise moral questions that are *informed by science* but also sensitive to the kinds of considerations that economists appeal to.

In raising moral questions, I'll mostly appeal to moral reasons, including the reasons we have to respect the interests of future people and the liberties of potential parents. In order to avoid repeating myself in each chapter, I want to give a quick overview of two ethical principles that have been widely discussed in the literature on biomedical enhancement.

Procreative beneficence holds that we should create children with the best chance of the best life.[4] Of course, parents will disagree about precisely what constitutes a good life, but

some traits enable us to live happy and healthy lives regardless of the particular goals we end up having. These include a well-functioning immune system, empathy, intelligence, and self-control. Of course, these traits are partly a function of environmental influences and developmental luck. So the principle applies to how we treat our children after they are born, as well as what kinds of children we create through genetic selection or modification. There are plenty of objections to procreative beneficence, and even if we accept it, it will be difficult for parents to know – if they are choosing among embryos – which embryo is likely to result in a person with the best overall prospects. This is because having some valuable traits, like creativity, may involve trade-offs with other valuable traits, like conscientiousness. There will also be uncertainty about which specific traits are likely to be good for a child in a rapidly changing environment.

Uncertainty can be crippling, but the usual response is to rely on heuristics and consult with experts. Indeed, genetic counseling is big business, and evolution has wired us to rely on heuristics to make all kinds of choices, including reproductive decisions. We are attracted to people whose traits tend to indicate their likelihood of producing healthy children. Obvious examples include facial symmetry (which may indicate a low mutation load), smooth skin for women (indicating youth and fertility), broad shoulders for men (indicating an ability to engage in combat and hunting), and the ability to entertain with stories and jokes (indicating creative intelligence). We can probably improve the primitive heuristics we're wired with by explicitly reasoning about the traits we'd like our children to have, and selecting a mate (or an embryo) based on qualities we think will contribute to a child's welfare. Procreative beneficence doesn't assume we can know exactly

what to do; it just implies that we should try to maximize the chance that our children will thrive given the available information and technology.

Procreative altruism holds that parents should select a child whose existence is likely to contribute more to the welfare of *other people* than any alternative child they could have.[5] Procreative altruism adds a much-needed caveat to procreative beneficence, reflecting the fact that what's best for each is not always what's good for all. On my view, the most interesting cases of genetic enhancement involve collective action problems. These occur when each of us pursues our own goals in a way that produces an aggregate outcome that is bad for all of us. The reason collective action problems exist is that many of our choices are interdependent, which means that the outcome for each of us depends on the choices of all of us.

A simple example of an interdependent choice is the decision to use antibiotics. If we use an effective antibiotic when we have an infectious disease that is unlikely to clear up on its own, we improve our own welfare. We also improve the prospects of people around us, since each of us is a potential vector of bacterial infections. But apart from the benefits of antibiotic use, the widespread and often *indiscriminate* use of antibiotics creates collective harms in the form of antibiotic resistant bacteria in a shared environment. Each person who has an infection (or each farmer who can moderately speed up the growth of livestock by adding antibiotics to animal feed) will be tempted to ignore the imperceptible social costs (or 'negative externalities') they impose on others. Bacteria resistant to antibiotics can be thought of as genetic pollution that we create as a byproduct of individually rational actions.

Similarly, I'll discuss cases in which *each parent* choosing in a way that increases the expected welfare of their child will

create a collective outcome that is less good than it would be if *all parents* (or *most* parents) chose otherwise. If there are health risks associated with selecting for height, for example, and if each of us chooses to have taller than average boys, we may end up (especially over several generations) with an outcome that nobody wants.

Selecting and editing embryos is an ethical issue because the choices parents make affect the prospects of the children they create, and social welfare more broadly. Reproduction is a social act because the collective upshot of our individual choices shapes the gene pool for future generations, and because the people we create will (to some extent) share a common environment. The environment includes not only the air they breathe and the land they live on, but also the culture and political institutions they share, the technology they create and transmit through exchange, and the kinds of people who will populate the planet.

The final chapter of this book takes up abstract issues that will arise if genetic enhancement technology becomes so cheap and ubiquitous that parents or governments can use it to create new kinds of people. It also addresses demographic worries, which arise from the fact that the reproductive choices we make now will dramatically alter the direction evolution takes, for better or worse. The final chapter was fun to write, but parts of it may be regarded by some readers as insufficiently tethered to what seems possible now. In a way, that's the point. In the tradition of science fiction, I hope to raise some issues that are of general interest even if technology never allows us to create people from scratch. Some of the lessons I draw might be applied to outcomes that more mundane genetic technologies make possible. And the questions addressed may inform the kind of world we aim to create.

NOTES

1 Uffelmann *et al.*, 'Genome Wide Association Studies'.
2 Since ethnic groups differ genetically (Murray, 2020), a GWAS performed on one group (such as East Asians) often has less predictive power for other groups (such as sub-Saharan Africans). But more data and better models that account for differences in ancestry can easily solve this problem, provided governments do not block scholars from obtaining this data – blocking access to genetic data increasingly occurs in the USA, due to the politically motivated fear that researchers will find racial differences in cognitive ability if they're allowed to look for it (Lee, 2022).
3 It will be important to select somatic cells subject to relatively low mutation rates since mutations from adult cells would be passed along to eggs. This will be true even if gene editing tools might be able to fix point mutations caused by radiation, mutagenic chemicals, or cellular division (Abascal *et al.*, 2021).
4 Savulescu, 'Procreative Beneficence'.
5 Douglas and Devolder, 'Procreative Altruism'.

Acknowledgments

Without Jason Brennan at Georgetown and Andy Beck at Routledge this book wouldn't exist. And without David Schmidtz, Jerry Gaus, and Cathleen Johnson, I would never have had the opportunity to spend a year in Tucson and share a hallway with Jason as visitors at the University of Arizona. Allen Buchanan's advice and encouragement, first at Duke and then at Arizona, was invaluable. I also want to thank Julian Savulescu for hosting me as a visitor at the Uehiro Centre for Practical Ethics at Oxford University, where I wrote this book in the summer of 2019. Thanks also to Craig Callender for making me a visiting scholar at the Institute for Practical Ethics at UC San Diego, and to Matt Zwolinski for making my time in San Diego possible. Students at Duke, Arizona, and San Diego provided me with memorable discussions, and my friends Bo Winegard, Nathan Cofnas, Filipe Faria, Dan Jacobson, Rishi Joshi, and Justin Tosi (among others) provided much-needed moral support in an age of fake outrage and intellectual conformity. I'm grateful to Bruce Caldwell and Mike Munger for inviting me back to Duke to give an early version of this book as a Hayek Lecture, and Damian Love for his copy-editing work. I also want to thank Dan Demetriou, Joseph Porter, Diana Fleischman, Geoffrey Miller, Louise Perry, Alex Kaschuta, Chris Williamson, Razib Khan, Luke

and Nicole Nosek, Claire 'Grimes' Boucher, Aparicio Caicedo, Marcos Alonso, Spencer Moore, Michael Christensen, Tobias Wolfram, and Matt Frost for helping me refine ideas and giving me friendly platforms to engage with a wider audience. Finally, I want to thank my parents for bringing me into the world and for supporting career moves that decreased my income but increased my freedom to explore ideas.

Although words like 'interdisciplinary' have been embraced by university administrators for marketing purposes, university *departments* – at least in the humanities and social sciences – have become ideological monocultures that operate within strict boundaries. Graduate students are often discouraged from pursuing topics that bring together insights from different fields in order to address big questions. Instead, they are encouraged to master a few tools and deploy a few assumptions in order to solve small puzzles. Scholars who pursue controversial topics are shunned, even punished, by the secular clergy that inhabits the modern academy. More than anyone else, Jerry Gaus taught me not to care what the busybodies in our profession think. He encouraged me to read widely and to avoid chasing prestige at the expense of truth. I dedicate this book to my mentor and friend, the most original thinker I know, the late Dr. Jerry Gaus.

Man is a rope, stretched between beast and superman – a rope over an abyss.

Friedrich Nietzsche, *Thus Spoke Zarathustra*

Smart People
1

Prometheus was punished for stealing fire from the gods and giving it to people. Fire symbolizes the arts and sciences – the fruits of our cognitive faculties. Although he was sentenced by Zeus to eternal torture for sharing his knowledge, Prometheus is seen by most readers as a hero, and Zeus as a villain.

People are ambivalent about intelligence. We understand it's a trait that distinguishes us from other animals. And most of us wish we were smarter, or at least wiser and wittier, which intelligence enables. But many people also think of high intelligence as a curse, in part because it allows us to see the imperfections of the world – including things we can't fix – and it leads us to contemplate the apparent meaninglessness of spinning around on a tiny globe near a dying star in a vast universe.

In this chapter, I'll give an overview of the individual and social benefits of intelligence. I'll consider worries some people have about boosting intelligence, discuss trade-offs parents will face in selecting specific cognitive traits, and then consider social dilemmas that might arise when each parent is left free to choose cognitive traits that are good for their children but potentially bad from a social standpoint. I'll end by considering the possibility that genetic technologies will facilitate so much inequality in cognitive ability that we will end up with unequal moral status. Unfortunately, I'll argue,

DOI: 10.4324/9781003464266-1

there is no way around this problem: technologies that allow us to transform our children's abilities will be in high enough demand that a prohibitive approach would likely increase the cognitive inequalities that restrictive laws aim to prevent from emerging.

INTELLIGENCE: WHAT IT IS AND WHY IT MATTERS

Intelligence is puzzling. After all, if it's so important, why didn't other primates – let alone other kinds of animals – develop it to the extent that we did? One limiting factor is that it's metabolically expensive to maintain the biological machinery that makes intelligence possible. Given how unusual high intelligence is in the animal kingdom, combined with the fact that the size of an average human brain tripled in only 3 million years, there must have been unusual selection pressures that favored its growth. Among these are the early tendency for humans to hunt and live cooperatively, and the consequent need to coordinate our actions with others, and draw up complex plans.[1]

Once intelligence became especially important for human survival and social coordination, it is plausible to suppose that it became sexually selected – much like a peacock's tail.[2] It's strange to think of the brain as an attractive ornament, but it is easy to see how the creative displays that large brains enable might indicate to potential partners one's ability to solve socially important problems.[3] And this may very well be an honest signal that's hard to fake. On this view, we find jokes funny and complex stories compelling in part because the ability to recognize superior creative displays of intelligence would have been crucially important to our ancestors. Once that was true, it's possible that sexual selection favored big brains by making signs of intelligence attractive beyond

their ability to solve mundane problems. Cultural norms may have also affected which kinds of creative display were attractive. Through this process, gene–culture co-evolution may have increased intelligence among some groups by directing people to seek out smart mates.

But what, exactly, *is* intelligence?

An influential view comes from Linda Gottfredson, who argues that 'intelligence is not the amount of information people know, but their ability to recognize, acquire, organize, update, select, and apply information effectively'.[4] Put more positively, intelligence is 'the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly, and learn from experience'.[5] This view is not intended to be controversial, but is instead supposed to capture our ordinary intuitions.

Yet some people, apparently for political reasons, want to deny that intelligence is real, that it is strongly influenced by genes, or that it can predict important life outcomes.[6] This reluctance to accept the results of intelligence research probably comes from a fear that if intelligence is mostly a function of genetics, and intelligence is unevenly distributed in the human population, egalitarian political ideals are hopeless. It may also stem from the sense that it's cosmically unfair that nature would dole out abilities so unequally.

There are a few responses to politically motivated resistance to intelligence research. First, whether something is true and whether we'd like it to be true are two different matters. Second, as I'll discuss in the final section of this chapter, whether intelligence differences undermine equality depends on precisely *what* egalitarian theories are supposed to achieve. Finally, if the conclusions of intelligence research are inconsistent with a certain set of egalitarian commitments, we may

have a choice: we can either revise our commitments, or alter people. There's no need to lie to ourselves or other people about the data. After all, if the premise of this book is right, we will soon be able to alter the traits of future people in ways that better satisfy our moral commitments.

Political worries aside, intelligence is real, measurable, and fairly stable across time.[7] Intelligence Quotient (IQ) tests are imperfect but powerful ways of gauging cognitive ability. And although there are different IQ tests, the results tend to correlate so highly that psychologists talk about *general* cognitive ability, or 'g' for short. Scores on 'g loaded' IQ tests predict a host of important life outcomes. According to a recent review, 'intelligence – often called general cognitive ability – predicts educational outcomes, occupational outcomes, and health outcomes better than any other trait'.[8] IQ is negatively correlated with crime,[9] and positively correlated with income.[10] Perhaps more surprisingly, high average intelligence in a population predicts social trust and economic development: smarter countries have less corruption and more wealth.[11]

Intelligence is also highly heritable. Although scientists are just now finding specific genetic variants associated with intelligence, we know a remarkable amount about the extent to which intelligence is influenced by genes. This knowledge comes from behavior genetics, which began as an attempt to infer the heritability of traits by observing behavior in the absence of any knowledge of the biochemistry that causes it.

Behavior genetics was born when Francis Galton began studying twins separated at birth in order to sort out the effects of nature and nurture on personality.[12] The methods for measuring traits have improved considerably, and the number of twins studied throughout their life course is now in the tens of thousands. The first rigorous studies began

in the 1970s, and we now have five decades of research, including thousands of papers published in peer-reviewed journals.[13] Intelligence is among the most carefully studied traits in psychology. Behavior genetics researchers have also studied many other traits, ranging from health and height to political ideology and religiosity, in order to figure out how heritable they are.

It is worth mentioning that heritability in the technical sense gauges the extent to which genes explain the *differences* between individuals within a given population. It is not a measure of how 'genetic' a trait is. There *is* no fixed number that indicates exactly how much of a trait is a function of nature or nurture. This is because genes interact with different environments and with random developmental forces to produce traits. So, for example, a population that includes some well-fed people and some malnourished people might have a lower heritability score for height than the same population would if everyone was malnourished or everyone was well fed (if all of us eat well, face very little stress, and so on, almost all of the differences in height between us will be genetic). Nevertheless, at the risk of oversimplifying, heritability scores can be thought of as indicating roughly how strongly genes influence traits.[14]

As it turns out, across a wide variety of populations, intelligence is about 60–80 percent heritable by adulthood. This means that, on average, genetics explains about 60–80 percent of the variation in intelligence between adults within a population.[15] Personality traits such as the Big 5 – Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism (OCEAN) – are about 50 percent heritable. While this does leave substantial room for environmental influence, the 'nurture' side of the nature/nurture equation

can be misleading. It does not mean parents and peers determine the non-heritable parts of our intelligence or personality. Environments play a role, but genetic predispositions lead us to seek out and actively shape our environments from an early age. According to one of the pioneers of twin studies, Robert Plomin

> Psychological environments are not 'out there,' imposed on us passively. They are 'in here,' experienced by us as we actively perceive, interpret, select, modify and even create environments correlated with our genetic propensities … For example, genetic differences in children's aptitudes and appetites affect the extent to which they take advantage of educational opportunities.[16]

Plomin goes as far as to say that the schools our parents send us to do not make much difference in the development of our aptitudes, even if they do help shape our worldview and values. Instead, 'the most important thing that parents give to their child is their genes'.[17]

Apart from the *individual* advantages of intelligence, there are substantial *social* benefits. In some ways, it is obvious why a nation with especially smart people would be more successful than others. Intelligent people who are given the opportunity to make full use of their talents will tend to produce more scientific and technological innovations.[18] But one of the most surprising findings that has emerged from intelligence research is that groups of intelligent people tend to cooperate more, and thus create the conditions for living together productively in a political society.[19]

Economists have long understood that formal political institutions and informal norms are important sources of

social order. They are the background against which trade is likely to be productive or unproductive. In societies full of free riders and corrupt politicians, it is harder to tell friend from foe, and more dangerous to invest in risky ventures that might have social benefits, but which are likely to result in personal failure. Trust changes everything. High-trust societies in which laws are impartially applied and private property rights are enforced are the most productive in the world. They are also the countries with the highest average IQ.

According to Garett Jones, while intelligence predicts cooperation in collective action problems, traits that correlate with intelligence – especially patience – seem to be a large part of why smart people tend to cooperate more. It is not that smart people have better moral motivations. Instead, smart people in high IQ groups tend to find each other, to employ mutually beneficial strategies in complex interactions, and to support policies that reinforce political institutions that increase prosperity.

This suggests that parents have a moral reason to boost their children's intelligence not only because it is likely to make their kids' lives go better, but because there are social benefits – or 'network effects'[20] – to having more intelligent people in a population.[21] However, there may also be good reasons *against* boosting intelligence. Let's consider some of them.

RISKS OF ENHANCING INTELLIGENCE

One worry about enhancing intelligence is that a few very smart people might – intentionally or not – inflict vast amounts of harm on other people. Ingmar Persson and Julian Savulescu have argued that we may wish to put the brakes on cognitive enhancement until we also learn how to morally

enhance our children.[22] I will discuss moral enhancement more in the next chapter. But it is worth recognizing the plausibility of their argument.

A smart psychopath is more dangerous than a mentally impaired one. More to the point, a world full of cognitively enhanced people is also one in which technological progress accelerates. This brings not only more rewards, but also more risks that a few bad actors might do serious damage. Even cognitively enhanced people might discount the risks of deploying new technology. With enough risky innovations over enough time, doom may be all but inevitable.[23]

In Bernard Shaw's brilliant play, *Man and Superman*, the Devil argues with Don Juan and concludes that people tend to invent more peaceful ways of living together, but also more efficient means of killing one another

> I have examined Man's wonderful inventions. And I tell you that in the arts of life man invents nothing; but in the arts of death he outdoes Nature herself, and produces by chemistry and machinery all the slaughter of plague, pestilence and famine … [T]he power that governs the earth is not the power of Life but of Death; and the inner need that has served Life to the effort of organizing itself into the human being is not the need for higher life but for a more efficient engine of destruction. The plague, the famine, the earthquake, the tempest were too spasmodic in their action; the tiger and crocodile were too easily satiated and not cruel enough: something more constantly, more ruthlessly, more ingeniously destructive was needed; and that something was Man, the inventor of the rack, the stake, the gallows, and the electrocutor; of the sword and gun; above all, of justice, duty, patriotism

> and all the other isms by which even those who are clever enough to be humanely disposed are persuaded to become the most destructive of all the destroyers.[24]

On this view, even well-meaning people often use destructive technology in the service of ideology. In fact, Nick Bostrom and Anders Sandberg, who share Persson and Savulescu's enthusiasm for enhancement, express a similar worry about boosting intelligence. They emphasize that 'education can enhance cognitive skills and capacities, but it can also create fanatics, dogmatists, sophistic arguers, skilled rationalizers, cynical manipulators, and indoctrinated, prejudiced, confused, or selfishly calculating minds'.[25] Cognitive enhancement through genetic selection can have the same effects if the heuristics and cognitive styles that lead us into sophistry and rationalization are heritable.

I will consider moral enhancement as a way to mitigate novel risks in more detail in the next chapter. But it is worth mentioning three brief replies to the worry that general cognitive enhancement might impose existential risks.

First, as discussed above, smarter people tend to create more stable and prosperous societies. In these societies, the rule of law works more effectively, and there are better mechanisms for identifying and catching criminals. This might mean that at the micro-level of communities and states, risks will be minimized, and that at the macro-level of global associations between countries, trust will be higher and corruption lower.

Second, banning technologies that allow parents to cognitively enhance their children is unlikely to prevent *everyone* from using them, given the enormous individual benefits they bring. In fact, banning them would likely increase the already large cognitive inequalities between different people since

the richest, smartest, and most powerful people would likely find a way to access black markets for cognitive enhancement. Third, parents will be able to shape the personality traits of their children through genetic selection. While personality is not as heritable as height or intelligence, it is *moderately* heritable. Conscientious people tend to make more money and do better at school, but also tend to be good friends and romantic partners. In other words, conscientious people tend to live more successful lives and treat other people well. For these reasons, it is likely that parents will want to select for conscientiousness. And this can be considered a form of both cognitive *and* moral enhancement.

Still, there is no fully satisfying reply to Persson and Savulescu's worry: cognitive enhancement without moral enhancement will bring with it unprecedented benefits *and* existential risks. It's impossible to know ahead of time whether the expected benefits of cognitive enhancement outweigh the unknown risks.

Other philosophers have a more mundane but still important worry about cognitive enhancement. They argue that boosting intelligence may yield unwanted side effects. For example, Michael Hauskeller cites evidence that smarter people tend to be more prone to depression and perhaps other mental health challenges as a reason to avoid enhancing intelligence.[26] If this were true, parents would need to consider both the potential costs and benefits of cognitive enhancement. But generally speaking, the best evidence suggests that intelligence is positively, not negatively, correlated with mental health. Not only do smarter people tend to live longer and healthier lives,[27] they also seem to suffer less from a variety of mental disorders.[28]

Of course, it's possible that people who see the world more clearly experience exceptional joy at the sight of a sunset over

the California coast, but also a greater awareness of the challenges that face humanity, or the flaws in the world around them. Deep thinkers aren't usually known for their cheery dispositions. However, anecdotes are cheap. It is simply too early to know for sure whether there may be thresholds above which selecting for IQ would have detrimental effects. So far, there is not much evidence that this is the case, and there is a lot of evidence that smarter people tend to enjoy better life outcomes as a whole. Only time will tell.

CAUTIONARY HEURISTICS

If the evidence is so strong that increased intelligence has big benefits, why would anyone worry about cognitive enhancement? Is skepticism toward cognitive enhancement simply an irrational bias in favor of the status quo? Not necessarily. Nick Bostrom and Toby Ord invented the 'reversal test' as a way of challenging status quo bias in applied ethics. They use cognitive enhancement as an example, but the test applies to any trait that we propose to alter from the baseline of where we are now.

According to Bostrom and Ord:

> When a proposal to change a certain parameter is thought to have bad overall consequences, consider a change to the same parameter in the opposite direction. If this is also thought to have bad overall consequences, then the onus is on those who reach these conclusions to explain why our position cannot be improved through changes to this parameter. If they are unable to do so, we have reason to suspect that they suffer from status quo bias.[29]

Consider two examples: height and IQ. Assume a couple is selecting among five embryos. Should they select the one in

the middle of the IQ or height distributions? Bostrom and Ord's point is that if people express fear about selecting an embryo that is above average height or IQ, or below average IQ or height, they may be under the illusion that average is automatically better. This is status quo bias, which reflects the assumption that we should favor what is normal or average for our species right now.

Bostrom and Ord are right that we often suffer from status quo bias. And Powell and Buchanan[30] are right that, for many traits, the status quo for a species at any particular point in evolutionary time is unlikely to be optimal from the standpoint of fitness or welfare. But we should balance this challenge to status quo bias against a principle that defends the status quo: 'Chesterton's fence'. The idea from GK Chesterton is that if we were to encounter a fence while walking along a road, we should try to understand why it was built and what purpose it might serve before succumbing to our urge to move it or tear it down. In the case of genetic enhancement, we should avoid making radical changes to the status quo until we understand how we got here, and what the dangers of large changes are likely to be. This is wise advice for parents and policymakers.

A reasonable conservative (like Chesterton) might say there are costs to ignoring the subtle consequences that might come if we make large and quick changes to a trait that we care about. This is especially true before we know the total phenotypic consequences of selecting or creating extreme genetic outliers. Bostrom and Ord might reply that there are opportunity costs to staying too close to the exact average distribution of traits that currently exists. Indeed, different ethnic groups have different genetically mediated traits, so a conservative reply to Bostrom and Ord may need to specify which ethnic group we belong to, and how far we should deviate from the average of that group.

I think we can balance these cautionary heuristics. We can avoid making radical genetic changes or selecting for extreme genetic outliers for some traits, while recognizing that sometimes we can be reasonably sure that Chesterton's fence is indeed a pointless roadblock rather than a socially significant signpost.

FROM GENERAL INTELLIGENCE TO SPECIFIC COGNITIVE TRAITS

If the considerations above are correct, parents will have a defeasible reason to cognitively enhance their kids, or to select for smart kids, up to a point. But *each* parent is not *all* parents, and coordinating our actions in a way that is good for all is challenging.

If we can assign polygenic scores to quantify the likelihood that an embryo will develop specific cognitive styles, or personality traits, parents will face hard choices. Some of these choices may involve moral dilemmas, but many will simply be a matter of personal taste. For example, evidence indicates that people who score high on conscientiousness and agreeableness tend to be good friends and co-workers, in part because they pay attention to and act on the needs of others, and because they delay gratification in the pursuit of plans.[31] But being agreeable makes you more likely to get taken advantage of by others, and conscientious people who are motivated to efficiently pursue goals may be considered less fun to be around by those who just want to relax.

Another example is extraversion. Extraverts tend to enjoy more sexual partners, and take more risks. But they're also less content to be alone, and perhaps less adept at quietly solving problems outside of social settings.[32] Again, parents will have different preferences for these traits, and it is not obvious that choosing someone who is likely to be introverted or

extraverted is immoral.[33] These are simple examples in which heritable cognitive traits will have costs and benefits, and will lead to different kinds of lives. But what's good for each isn't always good for all.

From a social standpoint, there seem to be benefits associated with cognitive diversity. Diversity has become a politically correct buzzword, and we should not overplay it. The Hong-Page Theorem is an influential model that illustrates the advantages of diverse cognitive styles.[34] The basic idea is that under the right conditions, a group of cognitively diverse people of average intelligence can solve problems better than a smarter group of people who think in the same ways. But the Hong-Page Theorem is a limited result applying to small teams of people trying to solve specific kinds of problems. It does not show that more diversity is always better, or that we can know how much cognitive diversity would be best across an entire political society. In fact, above some threshold – perhaps one that is relative to the kind of problem being addressed – more diversity can make coordination and communication more difficult, and can reduce social cohesion.[35] Nevertheless, cognitive diversity has benefits in some conditions. And it is conceivable that leaving parents free to select or enhance particular cognitive traits will produce a pattern in which there is less welfare than there would be if they found a way to coordinate their choices.

Suppose we can come up with polygenic scores so that people using IVF and PGT can choose personality traits that correspond with political ideologies.[36] Liberal personality types tend to exhibit an eagerness to experiment with new ideas and cultures. But people who score high on personality traits that correlate with political liberalism are also more likely to be taken advantage of by others, especially people with parasitic

personality types. Conservatives, by contrast, may be slower to pick up novel ideas from which we all might benefit, but also more likely to protect existing social and political orders from outside threats. It is plausible that a healthy society will have a mixture of personality traits that correspond with liberal and conservative political orientations.[37]

In cases like this, it is clear that if parents making choices for their own private reasons skewed future populations in one direction rather than another, there might be significant social consequences. In fact, this is already happening to the extent that conservatives, especially *religious* conservatives around the world have more children than liberal atheists.[38] Whether this is good or bad, the widespread use of embryo selection can easily alter the political and religious landscape of the human population, or sub-populations that are geographically and politically isolated from each other.

It is unclear what to do about social dilemmas like this. Government agents are generally not equipped to find or enact a socially optimal distribution of cognitive traits like personality or political orientation. So we have pretty strong reasons to leave parents free to make these choices on their own, even if their choices will be structured by social norms, and enabled by government policy. When there are demonstrable collective harms associated with individual choice, it is reasonable to impose some restrictions on choice for the welfare of future people. More on this in the final chapter.

POSITIONAL GOODS AND SOCIAL BENEFITS

Another way in which cognitive enhancements might be individually rational but collectively harmful is when parents enhance general intelligence or specific cognitive traits to chase positional goods. Positional goods are usually defined

as goods that are scarce, and confer social status, so that one person's consumption imposes a relative cost on other people.

An example is a medal in the Olympics, or admission to an elite school. If I win a gold medal in the Olympics, there's one less gold medal available for other competitors. If my daughter secures a spot in the class of 2040 at Duke University, others are less likely to get one. This makes the pursuit of positional goods appear to be a negative sum game. Scarce resources are spent trying to secure a prize that very few people can win, so it looks like a waste of resources from a social standpoint.

But the examples are incomplete. Competition over positional goods imposes net costs only if we restrict our attention to the people competing, and the prize they're competing for. As we all know, however, sometimes the competition itself is worthwhile, because it encourages each of us to develop character virtues. Training for a football match, or studying for an exam, can make us healthier, smarter, and more disciplined. And even when there's a loss of welfare for competitors because not everyone can win the prize, positive externalities may accrue to third parties: when teenage boys pick up a guitar in part to impress teenage girls, we may all end up with better music, even if the boy doesn't get the girl. When entrepreneurs compete for customers to gain money and status, and when comedians get on stage to overcome social anxiety and depression, those who consume the products they create or enjoy the jokes they tell are better off. Competition for positional goods may leave the world with a smarter population, better technology, funnier jokes, better music, and more enjoyable sports.

Intelligence is, in part, a positional good which enables us to tell better jokes, write better stories, and earn more money. It is also an all-purpose good that predicts better health, more

stable relationships, and financial success. If parents want to increase general cognitive ability to improve their children's prospects, it is likely to create positive externalities. I cited evidence above that the positive returns from cognitive enhancement may be *exponential* rather than *linear*. This is true even if there are threshold effects above which we get diminishing marginal gains, or decreasing utility due to unwanted side effects. We simply don't yet know what the net consequences of chasing the (partly) positional good of greater intelligence would be.

The overall lesson is that if each of us enhances the intelligence of our children in order to increase the likelihood that they'll win competitions for positional goods, this does not imply that there will be a net loss of welfare. Quite the opposite, in many cases. One reason free trade tends to increase productivity, and peace, is that it provides each of us with an incentive to figure out what we're good at, and what other people want, and develop our talents in ways that tend to be individually profitable and collectively beneficial. This fact suggests not only that enhancing general intelligence may be a net good, but also that leaving parents free to enhance specific cognitive traits is likely to be good to the extent that they choose traits that are socially valued. While parental choice could lead to too much conformity, in a free society it is likely that a diversity of cognitive styles will be in demand by mates, and by potential employers.

There is, however, a serious negative externality – or unintended harm – associated with cognitive enhancement. Those who do not enhance their children will suffer relative losses in social opportunities. At some point in the future, cognitive inequalities could become so great that different groups of people end up with different *moral* standing such that some people are regarded as morally better than others.

MORAL STANDING AND MORAL STATUS

A character in Bernard Shaw's *Man and Superman* warns

> Beware of the pursuit of the Superhuman: it leads to an indiscriminate contempt for the Human. To a man, horses and dogs and cats are mere species, outside the moral world. Well, to the Superman, men and women are a mere species too, outside the moral world.[39]

Is this true? If so, what should we do about it?

It's clear that those with less intelligence benefit from living in a society with a high average level of intelligence. Such societies, we've seen, tend to be richer, less corrupt, and more peaceful. But if economic growth continues as projected, most future people will populate societies that are technologically advanced. And it is not clear that those with less intelligence will be economically valued in a society with less need for manual labor. If cognitive inequality increases, those on the left side of the intelligence bell curve will also have fewer opportunities to engage in stimulating social activities, and may fare poorly in romantic relationships in a society with smarter people who value creative accomplishments.

Might this inequality of abilities eventually produce *moral* inequality? Peter Singer has argued that empirical findings about genetically based differences in intelligence shouldn't be taken to undermine the principle that people are moral equals. On Singer's view, all sentient creatures have interests that are worth protecting. What these interests are depends on what kind of creature we are (pigs have different interests than people) but also what properties each of us has (people with severe mental impairments don't have the same interests

as intellectuals, though they do have an interest in avoiding pain and frustration).

Singer concludes that if we could reliably rank individuals based on intelligence, 'enslaving those who score below a certain line on an intelligence test would not … be compatible with equal consideration. Intelligence has nothing to do with many important interests people have'.[40] This is correct. Even if Singer downplays the importance of intelligence a bit too much, he is right that we are not committed to the idea that every individual must possess an *equal* amount of whatever qualities give us basic moral standing. We just need *enough*.

Nevertheless, we can imagine encountering an alien species from another solar system that is much smarter, kinder, and more creative than we are. It is hard to argue that they aren't better than us, just as it's not much of a stretch to say that people are generally better than lobsters. Our capacities do not give us license to abuse the less able, and may give us special responsibilities to take care of them. But superior capacities do not automatically give us superior standing, because there are threshold effects: having certain rights and responsibilities is not strictly proportional to how much of a given trait we have.

Allen Buchanan usefully distinguishes the concept of moral *standing* from moral *status*

> Moral status and moral standing are sometimes used interchangeably, but … I will distinguish them. I will say that a being has moral standing if it counts morally, in its own right … Moral status, in contrast, is a comparative notion. Two beings can both have moral standing, but one may be of a higher moral status.[41]

Buchanan argues that all creatures with sufficient moral status have moral standing, or basic moral rights; but different individuals or groups may have different moral status if the differences between them are large.

I do not want to take a stand on the precise combination of traits that bestows some creatures with moral standing, or moral status. Usually sentience is taken to be sufficient for having *minimal* moral standing, because creatures capable of suffering have an interest in not suffering. Traits like consciousness, empathy, and rational capacities seem to confer higher moral standing, so that ordinary people have greater moral standing than lobsters. We owe people a certain amount of respect and autonomy not because we have fingers and toes that lobsters lack, but because we have traits that allow us to exercise intellectual capacities that lobsters lack.

On Buchanan's view, cognitively enhanced people may have a superior moral status to those who are unenhanced, even if all ordinary people have similar moral standing. This view is reflected in the common judgment that the world suffers a greater loss if a kind and creative teenager is killed in a car accident than if an elderly patient who has fallen into a permanent vegetative state (PVS) is killed by a lightning strike. The PVS patient lacks certain capacities and cannot reasonably hope to regain them, so we think that his life isn't worth as much. It is unfashionable to talk like this in our hyper-egalitarian political culture. But it is true. We all think some people are better than others, even in cases in which we think equal basic rights should be extended to all who meet a certain threshold.

These considerations strongly suggest that increasing cognitive inequality via genetic selection may not only result in some people having more opportunities to productively

engage with others. It will also result in some people having superior moral status to others: they will simply be capable of a richer life. Moreover, there may be no upper bound on moral status.[42] As inequalities increase, and absolute abilities change, those on the right-hand tail of cognitive abilities that we deem morally salient may feel sorry for those on the left-hand tail.

There are two possible remedies: subsidies and force. Some people say that we should subsidize socially beneficial enhancements for those who can't otherwise afford them. If some parents refuse to use genetic technologies to shape the cognitive capacity of their children, even if they can afford them because of subsidies, they might eventually be deemed criminally neglectful, much like parents who refuse to feed or educate or vaccinate their children. As John Stuart Mill observed

> It is not in the matter of education only, that misplaced notions of liberty prevent moral obligations on the part of parents from being recognized, and legal obligations from being imposed … The fact itself, of causing the existence of a human being, is one of the most responsible actions in the range of human life. To undertake this responsibility – to bestow a life which may be either a blessing or a curse – unless the being on whom it is bestowed will have at least the ordinary chances of a desirable existence, is a crime against that being.[43]

Mill advocated taking the least restrictive alternative to compel people to acknowledge their obligations as prospective parents. It is preferable if social norms rather than legal sanctions are used to pressure people to choose in ways that promote

their child's welfare. But if norms fail to work, Mill seems to think we might coercively prevent parents from reproducing, or making reproductive choices that would be detrimental to their children.

A less coercive but more radical alternative is to redesign political societies so that people have the right to form communities or states with a strong right to exclude those who choose to reproduce in a way that ignores the social consequences of their children's traits. If people were free to form new political communities (and set the rules for new entrants), perhaps they would cluster even more along the lines of intelligence and other traits that have network effects than they already do. Less successful political communities might then copy the reproductive norms of more successful communities. Of course, there are no guarantees. But small, stable political communities might be able to reintroduce group selection in a way that mimics the conditions that facilitated the spread of favorable psychological traits in the past.[44]

It may be worth encouraging autonomy among smaller political communities if for no other reason than John Stuart Mill's idea that we should encourage experiments in living. As the evolutionary biologist Joseph Henrich argues, until we understand psychology and institutions better, 'we should take a page from cultural evolution's playbook and design "variation and selection systems" that will allow alternative institutions or organizational forms to compete'.[45] Competition would increase, on this view, if communities had more freedom to experiment, and if people within communities felt the consequences of their choices more directly. This could create the emergence of favorable reproductive norms. It would also mean that cognitive inequalities were less of a problem if people were free to cluster in ways that led them to internalize the consequences of their reproductive choices.

NOTES

1 Henrich, *The Secret of Our Success*.
2 Miller, *The Mating Mind: How Sexual Choice Shaped the Evolution of Human Nature*.
3 The idea here is that the behaviors brains enable are a kind of 'extended phenotype' where genes not only shape bodies, but create bodies that are predisposed to alter the world in predictable ways (Dawkins, 1982). Examples are genes that enable beavers to create dams, birds to create bowers, and people to create poetry.
4 Gottfredson, 'Why g Matters: The Complexity of Everyday Life', p. 79.
5 Gottfredson, 'Mainstream Science on Intelligence', p. 13.
6 Pinker, *The Blank Slate: The Modern Denial of Human Nature*.
7 Haier, *The Neuroscience of Intelligence*.
8 Plomin and Stumm, 'The New Genetics of Intelligence', p. 148.
9 Beaver et al, 'Intelligence is Associated with Criminal Justice Processing'.
10 Ritchie, *Intelligence: All that Matters*.
11 Jones, *Hive Mind: How Your Nation's IQ Matters so much More than Your Own*.
12 Galton, 'The History of Twins as a Criterion of the Relative Power of Nature and Nurture'.
13 Plomin, *Blueprint*.
14 For a more careful formulation of what heritability means and measures, see Sesardic (2005).
15 The heritability score is lower for children and adolescents because their brains are still developing. Heritability grows with age, and then tends to stabilize during most of adulthood.
16 Plomin, *Blueprint*, p. 51.
17 Plomin, *Blueprint*, p. 83
18 Bostrom and Ord, 'The Reversal Test'.
19 Jones, *Hive Mind*.
20 Network effects occur when a technology or trait becomes increasingly useful as more people adopt it. For example, a personal computer or cell phone is of limited use until others adopt

it. And the more who adopt it, the more useful it is. The same can be true of intelligence: the more smart people there are, the more they can divide intellectual labor, exchange ideas, and create powerful new technologies.

21 Anomaly and Jones, 'Cognitive Enhancement and Network Effects'.

22 Persson and Savulescu, 'The Perils of Cognitive Enhancement and the Urgent Imperative to Enhance the Moral Character of Humanity'.

23 Bostrom, 'The Vulnerable World Hypothesis'.

24 Shaw, *Man and Superman*, p. 78.

25 Bostrom and Sandberg, 'Cognitive Enhancement', p. 322

26 Hauskeller, *Mythologies of Transhumanism*.

27 Plomin and Deary, 'Genetics and Intelligence: Five Special Findings'.

28 Brown *et al.*, 'Can You Ever Be Too Smart for Your Own Good?'

29 Bostrom and Ord, 'The Reversal Test', p. 664.

30 Powell and Buchanan, 'Breaking Evolution's Chains'.

31 Nettle, 'The Evolution of Personality Variation in Humans and Other Animals'.

32 Cain, *Quiet: The Power of Introverts in a World that Can't Stop Talking*.

33 Interestingly, some evidence suggests women choosing male sperm donors have a mild preference for shyness or introversion over extraversion (Whyte and Torgler, 2016). However, this study is based on Western women in 2015, who have enough money to shop around for sperm donors.

34 Hong and Page, 'Groups of Diverse Problem Solvers Can Outperform Groups of High-Ability Problem Solvers.'.

35 Gyngell and Easteal, 'Cognitive Diversity and Moral Enhancement'.

36 Political ideology is moderately heritable (Hatemi *et al.*, 2014), and people have strong preferences for selecting mates with a similar political orientation (Hatemi and McDermott, 2012). It is, of course, a gross distortion to divide people up into two basic political orientations. But it is useful for simplification purposes to do this.

37 Anomaly *et al.*, 'Great Minds Think Different'.
38 Hayford and Morgan, 'Religiosity and Fertility in the United States'; Peri-Rotem, 'Religion and Fertility in Western Europe'.
39 George Bernard Shaw, *Man and Superman*, p. 171.
40 Singer, *Practical Ethics*, p. 21.
41 Buchanan, *Beyond Humanity*, p. 210.
42 Agar, 'Why is it Possible to Enhance Moral Status and Why is Doing so Wrong?'.
43 Mill, *On Liberty*, chapter 5.
44 Many traits that we value originated in part from inter-group competition, but also through intra-group mate selection and differential success. In preindustrial England, for example, a large percentage of men who didn't possess the skills required for economic success – including industriousness – left no surviving offspring (Clark, 2007).
45 Henrich, *The Secret of Our Success*, p. 331.

Good People

2

Arete was a minor Greek goddess who embodied virtues like wisdom, strength, discipline, and justice. The word 'arete' in ancient Greek is synonymous with virtue. Moral virtue becomes more important as our lives become increasingly interconnected through travel, trade, and technology. Technology enables us to manipulate the world around us. We can harness atomic energy to create nuclear power; we can alter viruses to use them as vaccines; and we can use computational biology to study how genes create proteins and influence behavior.

But all of this means that a small number of malevolent actors might use the information scientists gather and technology engineers create to harm vast numbers of people. We can imagine terrorists using nuclear weapons, genetically altered viruses, or drug-resistant bacteria, to wipe out their enemies.

One way to counter these threats is to create political institutions that increase trust and minimize risk. Private property rights increase autonomy and prosperity, and public health measures decrease the risk that people around us might spread dangerous diseases. In effect, these institutions lower the cost of treating strangers with kindness rather than suspicion.[1] But the institutions that create and enforce these rules are only as good as the people who occupy them, so it may be that robust

DOI: 10.4324/9781003464266-2

institutions require better people than those who currently populate our planet.

Some traditional debates in political philosophy concern whether we should take human nature as a parameter and build institutions around it, or whether we should try to stretch human nature and attempt to improve people though education, religion, or parenting. The environment can, of course, significantly affect how we treat people. But until recently, it wasn't possible to alter our nature to change our moral dispositions. We could only tinker with the institutions we live under, or the environment we occupy.

One kind of moral enhancement can occur through changing our biochemistry. For example, some people experiment with drugs like ecstasy to enhance their relationships or sex lives. Many more use alcohol and marijuana for the same purpose. A number of scholars have argued that we should encourage people with antisocial dispositions to biomedically enhance their moral capacities. For example, some judges offer convicted sex criminals the option of chemical castration in exchange for a reduced sentence.[2] More modestly, some psychologists encourage children with attention deficit disorder to use drugs like Ritalin so they can concentrate in class.

I will focus on efforts by parents to *genetically* enhance their children in ways that attempt to produce morally better motivations, behavior, or outcomes. Since genes affect behavior in large part by altering hormones and receptors, it's useful to say a bit about how hormones might be used as agents of moral enhancement.

THE BRIGHT SIDE OF OXYTOCIN

Parents spend a great deal of time worrying about the moral character of their children. Recent work in behavior genetics

suggests that our moral dispositions and political orientations may be transmitted more through genes and peers than parenting.[3] Whatever the relative role of genetic and non-genetic factors in shaping our moral character, it is worth thinking through what kinds of moral characteristics parents would want to enhance in their kids, and how these might be good or bad from a social standpoint.

A trio of philosophers at the Oxford Uehiro Centre for Practical Ethics has argued in favor of using biomedical technology to improve our moral dispositions. Tom Douglas defends the view that it's morally permissible to use drugs or chemicals to enhance *ourselves* in certain circumstances.[4] Ingmar Persson and Julian Savulescu make a much stronger case that, if it becomes safe, we should encourage (perhaps even require) parents to genetically alter their children in ways that promote morally good motivations, and outcomes.[5]

The main targets for moral enhancement would presumably be hormones (and their associated receptors) that predispose us to be more empathetic, or to care more about fairness. Oxytocin, cortisol, and testosterone, for example, seem to affect empathy, aggression, trust, and a tendency to care about norms of justice. These hormones interact with each other and with genes in complicated ways. But we know that each of these hormones can affect behavior even in isolation.

For a vivid illustration of how oxytocin affects moral behavior, consider the Ultimatum Game (see Appendix A for more details). One person (Proposer) is given $10 to split between himself and another person (Responder), and any split is permitted, provided the Responder agrees to it. If the Responder rejects the offer, no money is dispensed. Many Responders will reject a very low offer (say, $1) because they consider it unfair. When people are administered oxytocin before the

experiment, they tend to make more generous offers when they're in the position of Proposer,[6] and when their serotonin levels are artificially lowered, they tend to reject very low offers when they're in the position of Responder.[7] These results strongly suggest oxytocin is bound up with generosity, while serotonin affects our sense of fairness, or our desire to punish unfair behavior.

Although we can distinguish germline genetic enhancement of embryos from using drugs or hormones to enhance someone who is already born, what genetic enhancement would presumably accomplish for embryos is to change levels and ratios of hormones, and the uptake of hormones by the receptors that translate hormones into emotional states and behavioral dispositions. This is even more complicated than it might seem since different people have different baseline levels of hormones, and different tendencies for those hormones to rise or fall in response to environmental stimuli, such as stressful or competitive situations.

Still, it's conceivable that we could find (and select for) clusters of genes that tend to alter hormones in ways that predictably make people more generous,[8] or have a greater sense of justice. Persson and Savulescu think that of the many ways we might morally enhance our children, we would primarily aim to strengthen their sense of justice and their altruistic motivations. Although there are more dimensions to morality than justice and altruism, Persson and Savulescu are right that these are crucial targets for enhancement if our goal is to get our children to behave in ways that take account of other people's suffering and needs, and to exhibit concerns for fair solutions to problems that arise from the suffering of other people or animals.

Even if we accept the plausibility of Persson and Savulescu's goal, however, there are biological complications. There are

trade-offs between different aspects of morality that we'd like to enhance, and problems of coordinating the choices of parents so that the upshot of individually innocuous choices is collectively beneficial.

THE DARK SIDE OF OXYTOCIN

Some have argued that we can increase empathy by manipulating the production or uptake of hormones like oxytocin, cortisol, and testosterone. Oxytocin seems especially promising since we know that it has a positive association with empathy, which underlies altruistic motivation. Many studies have found, for example, that if we spray a room with oxytocin before subjects in an experiment play a one-shot 'Prisoner's Dilemma' (PD) game, subjects are more likely to cooperate (see Appendix B for more about PDs). We also know that by simply allowing people to talk face-to-face before they play a PD, their oxytocin levels naturally rise and cooperation tends to increase.

The way oxytocin elicits altruism is by increasing empathy. But empathy is complicated, and more empathy is not always good from a social standpoint, even if it facilitates cooperation between discrete individuals.

It's important to distinguish ***cognitive* empathy** (which allows us to understand another person's perspective) from ***affective* empathy** (which allows us to feel another person's emotional state, and to respond appropriately). The consensus is that cognitive empathy has a weak relationship with altruism, but affective empathy tends to motivate altruistic action.[9] So it would seem that by increasing the amount of oxytocin coursing through our bodies, or improving the efficiency of oxytocin receptors, we'd increase affective empathy and with it a desire to help other people.

This seems like good news. If oxytocin can increase altruism, maybe we should all inject ourselves before business meetings, political summits, or any other event in which all of us can benefit from a deal that requires trust. We should also seemingly select embryos to increase the production or reception of oxytocin in future people.

But oxytocin has a dark side. While it does increase empathy for people who are predisposed to be especially selfish, it has more mixed effects on prosocial people, who are predisposed to be more empathetic. Administering oxytocin seems to increase prosocial, or altruistic, behavior mainly in people with emotional deficits, including those on the autistic spectrum.[10] Even then, it seems to increase cooperation only with those who are in close proximity to the person whose oxytocin is boosted. It does not seem to produce general altruism, but instead altruism toward the specific people one interacts with.[11]

A related effect of oxytocin is that by leading people to empathize more with those around them, and to contribute more in Ultimatum Games, it also leads them to think in less consequentialist terms.[12] In other words, boosting oxytocin seems to increase empathy and altruism toward the specific people with whom we are interacting (our temporary ingroup), not toward people in general. In fact, it may lead us to decrease the weight we put on the interests of anonymous people, which is generally the opposite of what proponents of biomedical moral enhancement envision.

A more concrete implication is that since affective empathy seems to increase *parochial* altruism, more empathy is likely to increase ethnocentrism.[13] More specifically, when there is competition between groups for resources, oxytocin seems to increase generosity toward members of one's

perceived in-group, while increasing hostility toward members of out-groups. According to a recent review, oxytocin 'plays a critical role in driving in-group love and defensive (but not offensive) aggression toward out-groups'.[14] But even then, while oxytocin boosts empathy and generosity toward one's in-group among people with an empathy deficit, it also seems to *decrease* generosity among those who are genetically predisposed to be generous. According to Declerck and her colleagues, this makes evolutionary sense: 'to avoid extreme gullibility of naturally cooperative prosocials, OT [oxytocin] might cause them to be more cautious, even to ignore social cues' when there is some risk that they may be taken advantage of by more selfish group members.[15]

The effects of oxytocin seem to differ based on our genetic predispositions and environmental stimuli. In theory, this poses no problem for genetic enhancement, since lots of traits arise from the interaction of genes and environments. But an implication may be that we cannot increase general altruism or a broader concern for impersonal principles of justice simply by boosting oxytocin or altering oxytocin receptors. As Powell and Buchanan emphasize,[16] if Persson and Savulescu think of moral enhancement mainly as a way of solving global problems that require the coordination and contribution of billions of people, oxytocin alone is not a promising candidate, since it looks like it may promote parochial altruism and make us more likely to focus on specific people than statistical lives.

Another biochemical way of boosting empathy is to alter testosterone/cortisol ratios. Evidence suggests that high testosterone and low cortisol levels are associated with low levels of empathy, and it is well known that men (who have higher average levels of testosterone) tend to exhibit less *affective*

empathy than women.[17] A related phenomenon is that men are more than twice as likely than women to be psychopaths, and also more likely to be autistic.[18] If Baron-Cohen is right, both of these involve empathy deficits: psychopathy involves an affective empathy deficit, while some forms of autism involve low levels of cognitive empathy. But so far, no chemical interventions work to significantly boost the affective empathy of psychopaths or the cognitive empathy of people with autism.

Since psychopathy and autism are highly heritable,[19] it is likely that we'll eventually be able to assign a polygenic risk score to embryos and screen out those likely to develop these conditions. However, it is important to distinguish low functioning autism, which can be crippling and lead to a life of dependency, from Asperger syndrome, which is sometimes called high functioning autism. People with Asperger syndrome usually live perfectly good lives, though they tend to be socially awkward and exhibit thoughts and behavior that involve high levels of systematizing (this is why Asperger and low functioning autism were grouped together in the past). People with Asperger syndrome often excel in careers like engineering and computer programming, which require systematizing more than empathizing.[20] For this reason, there's no overwhelming reason to select against Asperger syndrome.

PATHOLOGICAL ALTRUISM

Assume for the moment that we have reliable ways of ranking an embryo's chance of developing into a person who tends to exhibit more altruism, a strong sense of justice, or both. The principle of procreative beneficence says parents should select the embryo which, of all the embryos available, will result in a child with the best chance of the best life.[21] The principle of

procreative altruism suggests that we should select embryos that maximize the welfare of future people who our child is likely to interact with.[22] If altruism and a sense of justice are part of a good life for the child, and are likely to lead a future child to treat others exceptionally well, it seems like both principles imply that parents should choose an embryo likely to develop into a child with exceptional levels of these traits.

But this is not true.

First, each of us exposes our children to grave risks unless nearly everyone else also genetically enhances the moral motivations of their children in similar or complementary ways. The fact that there may be advantages to each to being slightly less cooperative than most (provided their treachery goes undetected), and that some parents will probably decline to enhance their children, creates a serious collective action problem. The problem is that those who decline to enhance, or who exploit the enhancements of others by selecting for traits that allow their children to gain relative advantages, make moral enhancement a risky strategy. This is presumably why Persson and Savulescu think that certain forms of moral enhancement might be made mandatory.[23]

Apart from problems with the political feasibility of enforcing mandatory genetic enhancement, it is unclear how we can harmonize our private choices in a way that will produce a beneficial overall outcome. The most general worry is that even if we can imagine an optimal distribution of moral traits, enhancing altruism, or a sense of justice, may not be an evolutionarily stable strategy. A strategy is **evolutionarily stable** if it can survive indefinitely in competition with other strategies in particular environments. Some strategies are stable across a wide range of environmental niches, and against a broad set of other strategies. **Conditional cooperation**, also known

as 'reciprocal altruism' in biology or 'tit for tat' in politics, is an example of an evolutionary strategy that is stable not only relative to many different environments and strategies, but even across species.[24]

Some of the most interesting ways of testing this are in the context of PD tournaments. The PD is a simple game first described in 1950, and it has become synonymous with any situation in which there are joint gains from cooperation but in which each player of the game is best off defecting from a cooperative agreement (see Appendix B for details).

Game theorists who invented the PD applied it to economic interactions and military strategy. But its applications are so ubiquitous across the animal kingdom that it has elicited much more attention than any other game (a 'game' in the technical sense is just a strategic interaction in which the outcome for all players depends on the choices of each player). In 1980, Robert Axelrod and Anatol Rappaport organized a tournament in which a diverse group of academic luminaries were asked to submit strategies to see which were evolutionarily stable in an extended PD game.

What they found is that the strategy to commit to cooperating no matter what the other players do is easily invaded and deeply unstable. It is obvious why. If a mutant strategy evolves (whether through a genetic mutation or a cultural innovation like a militaristic religion) it will quickly exploit the cooperation of the 'nice' strategy and either directly destroy it or breed it out of existence.

Before drawing any lessons for moral enhancement, let me say a bit about the PD tournament. The game for which academics were asked to submit a strategy to the tournament was just a generic payoff matrix that fit the ordering of a PD. The game assigned points instead of years in prison or

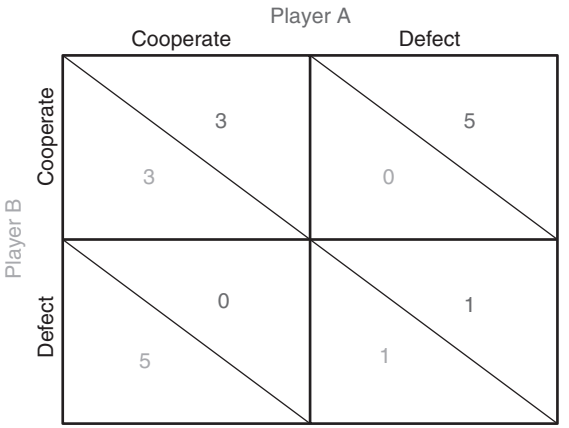


Figure 2.1 A Prisoner's Dilemma

ranked payoffs. So, for example, suppose mutual cooperation is assigned 3 points and mutual defection 1 point; whereas if I cooperate and you defect I get 0 and you get 5, and if you cooperate and I defect I get 5 and you get 0. Here's a visual representation (Figure 2.1).

In the tournament, the game was repeated many times, and paired different strategies against each other. There are an enormous number of possible strategies, and hundreds were submitted to the tournament. But we can simplify them as different variants of three basic types: always cooperate, always defect, or conditionally cooperate – that is, cooperate if the other player cooperates in the previous round, and defect if the other player defects in the previous round. While the strategy to always defect leaves players with massive unexploited gains from cooperation, it can survive in some environments, and it can dominate the strategy of always cooperate. If we think about a population of organisms or a colony of bacteria in a petri dish, we can visualize how those

who never cooperate would proliferate at the expense of those who cooperate indiscriminately.

When players can detect and remember the past moves of others, when they care about the future enough, and when they play against a variety of other strategies, conditional cooperation is evolutionarily stable. This is because it enables a player to protect himself against the exploitation of defectors; but it also allows him to enjoy the benefits of cooperation. In some ways, this is obvious, especially in the simplified version of the game I've presented.

But more recent work in experimental game theory shows that a lot of human cooperation is not based simply on reciprocity. It is not just a matter of maximizing the long-run benefits that each player anticipates for himself if he forgoes a current temptation to defect in a PD. Instead, some people seem to *enjoy* cooperation, and are willing to sacrifice some of their own resources and incur significant losses in order to mete out punishments to free riders.

The best way of testing this idea is with a 'Public Goods' game that's similar to (and sometimes diagramed as) a PD. Here's a simple version: recruit 50 players and give each of them 10 dollars. Then inform them that any money they contribute to a public account will be immediately doubled and redistributed equally to the group. In this game, if everyone gives all $10 of their initial endowment, they get $20 back, no strings attached. But each may think 'if I give 0, and everyone else gives $10, I can walk away with $29.60'. This is because if I hold on to my initial $10 endowment, and everyone else invests, I get 1/50th of their doubled investment (= $19.60) in addition to the $10 I kept. The profit-maximizing move is to give nothing, and hope that everyone else gives something (see Appendix C for more details).

If players are purely self-interested, and if investments are anonymous, the rational strategy is to give nothing. When early versions of this game were played scholars found that, when the amount available to invest is modest, and the groups are small, *most* people invest about half of their endowment, with some giving nothing, and some giving everything to the common pot. When asked why they choose to give about half, typical responses are that 'half seemed fair' and that 'I'd give more but I wasn't sure if I knew other people would too'.[25] This behavior was surprising to those who model people as purely self-interested wealth maximizers.

To tease out whether this behavior was stable, experimenters began repeating the game so that after multiple rounds they could detect patterns. The initial experiments of a repeated Public Goods game suggested that contributions tend to decline in subsequent rounds. Some economists interpreted this as players learning how to play the equilibrium, self-interested strategy.[26]

But this hypothesis was suspicious to those who were not wedded to treating self-interest as axiomatic. We witness generosity in everyday life, and people clearly care about justice (as well as *appearing* to be just, which wouldn't be profitable unless some people *actually* cared about justice). Why else would we go out of our way to help a vulnerable stranger in a foreign country, or get angry about someone for cutting in line and speeding ahead of people who are patiently waiting to board a train or an airplane? Why would people give anonymously to charities? It's true, of course, that much generosity is done publicly (which allows us to gain the esteem of others), and often our motives are mixed. We also self-deceive, sometimes convincing ourselves we made a sacrifice purely for a friend in need or a vulnerable stranger, when in

reality we might have been partly driven by the rewards we anticipate. But none of this makes sense unless some people, some of the time, really do consider generosity and justice morally virtuous.

In fact, later social scientists tested the self-interest hypothesis by adding a twist to the repeated Public Goods game. Experimenters introduced a mechanism that allowed subjects playing the game to identify and punish free riders in previous rounds. The mechanism allows players to identify those who invest little or nothing in any given round, and then impose costs on them. The self-interest hypothesis would predict nobody would do this unless there were net benefits for that person. But in fact, many subjects seem to take pleasure in punishing free riders, even when they incur a net personal cost. People really care about fairness.

Some experimental game theorists labeled the disposition to punish free riders, even at a net cost to oneself in any particular round, 'moralistic aggression' or 'altruistic punishment'.[27] Indeed, when subjects are asked why they cooperated more or less in any given round, they often identify a concern for fair outcomes, and a desire to retaliate against free riders.

This pattern of behavior, as well as the explanations for it that subjects give, strongly suggests that at least in small-scale Public Goods games with modest stakes, the main reason for not investing large amounts in the public pot is a desire to avoid being exploited by free riders.

Bowles and Gintis coined the term 'strong reciprocity' to describe a suite of traits exhibited by people in repeated Public Goods games – and in real life. Strong reciprocity is morally richer than conditional cooperation, which they call 'weak reciprocity'. Instead of cooperating *only* when others

cooperate, and in direct proportion to the degree to which others cooperate, strong reciprocators initiate cooperation, are eager to ramp up cooperation, and are willing to punish non-cooperators, even at a personal cost. Bowles and Gintis argue that most people in situations in which there are joint gains from cooperation prefer that everyone in a group play a 'fair' strategy, and that this preference was selected through gene–culture co-evolution. In other words, most of us have evolved to be 'strong reciprocators'.[28]

As with most heritable traits, strong reciprocity exhibits variation, and some people (psychopaths) are incapable of it. This makes the capacity for 'strong' reciprocity a precarious biological adaptation that can easily be undone if gene–culture co-evolution moves in a different direction in different groups, or across the whole human race. 'Strong reciprocity' is evidently an evolutionarily stable strategy since it is robust against many other strategies. But it is vulnerable to exploitation by 'weak reciprocators' who are generally willing to cooperate when others around them do, but who seek opportunities to defect against strong reciprocators. They might do this when monitoring costs are high and when trust is high because nearly everyone else in a population is a strong reciprocator.

Just as it is obvious why 'always cooperate' rewards parasites who play 'always defect', we can see why 'strong reciprocity' is a precarious strategy vulnerable to invasion by 'weak reciprocity'. Again, the robustness of a strategy depends on the ability of others to monitor their behavior, or detect what kind of player they are even in the absence of observable behavior.

When a weak reciprocator invades a society of predominantly strong reciprocators, he can exploit their trust. Weak

reciprocators are especially dangerous because, if motivations are opaque and go undetected, weak reciprocators can fool people into joining cooperative schemes from which they disproportionately benefit. If their strategy spreads through cultural or genetic evolution (or both), eventually strong reciprocity will begin to diminish. Another way of saying this is that if we care about enhancing justice and altruism (plausible ways of fleshing out 'strong reciprocity'), we should be on guard against reproductive choices that undermine it.

If some of us select for children that are motivated to play a robust version of the 'strong reciprocity' strategy, unless most others do too, or our children have a reliable way of detecting and discriminating against weak reciprocators, we may make the world a worse place, rather than a better place.[29] For this reason, attempts to morally enhance our children could be collectively self-defeating. This is an example of ***pathological* altruism**[30] in which some parents attempting to make the world a better place inadvertently make it worse.

Another way to put the problem is that each parent trying to satisfy the principle of procreative beneficence may leave the world with less welfare rather than more unless they avoid individuals or groups who are weak reciprocators, or non-reciprocators, rather than strong reciprocators. Moreover, depending on which strategy predominates in a population, and how easy it is to monitor and punish free riders, the principle of procreative beneficence could commend choosing either a more selfish child than average, or a more altruistic one. There is no determinate answer to whether procreative beneficence or procreative altruism commends creating kids with better moral motivations. It all depends on what other parents are likely to do in particular environments, and which

strategies predominate in a particular population, and are likely to do so in the future.

This is not an objection to the principles of procreative altruism or beneficence, but an important implication. The dynamics of social choice must be studied carefully before theorists or parents can move from moral principle to individual action.

DOES MORAL ENHANCEMENT UNDERMINE FREEDOM?

John Harris has challenged proponents of moral enhancement by arguing that selecting for traits like empathy or other sources of moral motivation may undermine our freedom by removing our *capacity* to act in immoral ways.[31] He also argues that altering our moral motivations does not make us more virtuous people unless we also act for the right *reasons*.[32]

The basic idea behind the argument that enhancement undermines freedom seems to be that if we're incapable of behaving immorally, then we cannot be praised for doing the right thing or blamed for doing the wrong thing. An influential French aphorist said 'nobody deserves to be praised for goodness unless he is strong enough to be bad'.[33] And Friedrich Nietzsche's fictional character, Zarathustra, said 'I have often laughed at the weaklings who thought themselves good because they have no claws'.[34]

Even in its strongest form, though, it is not true that an incapacity to act viciously undermines our freedom. This is because we may be *responsible* for rendering ourselves psychologically incapable of harming an innocent person. If I make myself less capable of doing something I judge to be awful, this looks like it decreases some part of my freedom to do otherwise, but increases my freedom to accomplish my

highest goals. One way of creating an attenuated capacity to do what I consider wrong is through a psychological 'Ulysses contract'.[35] This involves conditioning myself so that it's psychologically easier to do what I consider good, and harder to do what I consider bad. Similarly, if I purchase a drug or administer a chemical that makes it harder (or impossible) for me to do what I consider bad, this either enhances my freedom to pursue the ends I most approve of, or reduces my freedom, but does so in a way that's morally desirable.

Freedom is, after all, only one good among others.[36] Even if freedom has some intrinsic value, part of the reason we value freedom is that it helps us accomplish more specific goals. Among those goals may be preserving the ability to act in ways we value in the future. For example, I may order you to seize my car keys and hide them from me after I've had a few pints at the pub so that I can't drive drunk. In doing so, I have empowered you to reduce my freedom (in the narrow sense of having as many options as possible at a particular time), but this is clearly not objectionable, and it is arguably true that my long-run freedom to accomplish the goals I care about most is increased.

Still, there is an important difference between an adult biomedically enhancing *herself* in ways she thinks will make her a better person, and selecting or editing an *embryo* because she thinks it is more likely to develop into a person with a certain moral disposition. But as with other kinds of enhancement, this does not automatically imply that we are reducing the future person's overall freedom. And it certainly doesn't mean we are reducing the child's overall welfare. Far from it.

By creating a child with a higher probability of treating people well, at least if there's reason to believe that enough other future people will also be enhanced in similar ways, we

may be giving her opportunities she wouldn't otherwise have. If I am psychologically disposed to break contracts, to act impulsively, or never help strangers in a society in which the opposite is expected, and my behavior is easily detected, I am worse off on net. It is a complicated question, though, whether in a society with mixed moral motivations – which is very likely to emerge from widespread access to genetic enhancement technologies – a parent should select an embryo for one set of moral dispositions rather than another. The question cannot be answered in the abstract. It depends on the social dynamics at any given time. And answering this question is not needed in order to dispose with Harris's argument that moral enhancement undermines freedom. Enhancement does not *necessarily* undermine freedom, and even when it does, it is not always morally objectionable.

A more compelling complaint Harris has against Douglas, Savulescu, and Persson is that enhancing moral motivation does not, by itself, enhance moral character. It may be that having more people in a population who are moved by a sense of justice and altruism produces better outcomes. But better *outcomes* don't imply that we have better *people* in the sense that they do things for the right reasons.

To see why, consider the example of someone who helps a stranger simply because it feels good to do so, or when he expects praise from bystanders, or rewards in the afterlife. According to a commonly held view of morality, he is not acting for the right reasons, even if the outcome is good. Harris suggests that moral judgments must 'have cognitive content' in order to count as genuine moral reasons, rather than mere impulses.

Whether a reason must have cognitive content to count as a *moral* reason is disputable. But let's grant the premise.

Enhancing the dispositions that underlie our moral judgments, or the motivation that leads us to act according to those judgments, does not preclude us from moral reasoning. If anything, it *enables* us to devise moral reasons (with cognitive content) even if it doesn't guarantee that we will. To take an example, if I am naturally moved by the plight of animal suffering, I may be more likely to want to help animals, but also more likely to develop reasons – and act on these reasons – for why we should abolish the cruel conditions in which many farm animals are kept.

Harris gets an important point right: having motivations that incline us toward acting well doesn't ensure that we'll act for the right reasons. But this isn't a reason against enhancing ourselves or our children, and it may be a reason in favor of it.

BIOCULTURAL MORAL ENHANCEMENT

It's hard to separate biology and culture. After all, people are influenced by culture, and culture is an offshoot of psychological traits that are sifted and sculpted by evolution. The reason people can read books and peacocks cannot is not that peacocks don't have internet access or library memberships. They simply don't have the capacity to make good use of our social innovations, including schooling. We are a deeply cultural species, so the artifacts we create can be considered an extended phenotype.[37] That is, the artifacts we create – like tools for building houses and social norms that determine who is considered an attractive mate – are influenced by genes acting at a distance. Culture is, in part, an extension of biology. But it also shapes our biology by influencing which genes will find their way into future bodies.

Nevertheless, it may be worth preserving the *conceptual* distinction between cultural and genetic influences on people,

recognizing that both matter, and that genes and cultures co-evolve.

In the debate about moral enhancement, a central question is whether in the near future cultural innovations or biological interventions will improve the character of humanity. I began the chapter with the reasons why some philosophers endorse moral enhancement: rapid proliferation of technology will increasingly allow a small number of people to inflict grave damage on many other people. The motivating question in the debate is how to prevent this.

Douglas, Savulescu, and Persson have argued that we should aggressively research ways of genetically or biochemically altering ourselves and our children to solve global collective action problems that require many people to contribute small amounts.

Russell Powell and Allen Buchanan have given compelling arguments in favor of biomedically enhancing ourselves provided the procedures are safe, and collective harms are minimized. They do not oppose genetic enhancement in general. But they are skeptical that it will work as a means of moral enhancement as well as more traditional institutional improvements. Powell and Buchanan argue, contra Persson and Savulescu, that we should focus on altering institutions rather than embryos to improve moral motivations.

The debate over moral enhancement began with a concern to save humanity from very bad outcomes. The motivating idea is that we should look for ways to increase our willingness to sacrifice a bit more of our own welfare, even when it's not in our narrow self-interest, in order to solve large-scale collective action problems. These problems range from preventing nuclear proliferation to achieving herd immunity from infectious diseases.

In societies in which political leaders have some degree of accountability to their citizens, laws can only work if they have widespread support. And citizens who are myopic or apathetic are less likely than citizens who are far-sighted and altruistic to support laws that impose significant costs on themselves for the sake of long-run collective benefits. Institutional solutions work only to the extent that the people who shape the institutions are appropriately motivated.

Before discussing Powell and Buchanan's critique of Persson and Savulescu, I want to emphasize that not everything Persson and Savulescu think of as collective action problems really are. For example, while they're right that preventing rapid climate change or nuclear proliferation are collective action problems, they are wrong to argue that global wealth inequality is in the same category (2017). There is disagreement among scientists on the causes of economic inequality. And there is deep disagreement among ethicists on whether *inequality itself* is bad or if instead only *poverty* is bad.

A common view among economists is that poverty and wealth inequality are caused by poorly functioning institutions, and other variables. Although there are exceptions to every rule, wealthy countries have typically *not* made other countries poor. Poverty is the norm in human history, and *wealth* – as well as the *wealth gaps* that economic growth creates – is what stands out in need of explanation.[38] The consensus view is that recent economic growth is caused by formal and informal institutions that have evolved over centuries. These institutions tend to involve private property, an impartial judiciary, and a population of people who share norms and values that increase trust and decrease transaction costs.[39] Institutions can also shape the traits of populations through culture–gene

co-evolution, which in turn leads people to create societies that are more or less wealthy.[40]

Apart from the causes of wealth disparities between and within countries, wealth inequality is not the kind of problem for which there are prudential reasons for all of us, regardless of our moral views, to try to solve. While most people think extreme poverty is bad, and many are willing to do something to help alleviate it, wealth inequality is not the same thing as poverty, and some philosophers think focusing on inequality is a distraction from what really matters: having enough.[41]

Finally, it is worth emphasizing that even if our goal is merely to alleviate poverty in other countries, the problem may not be that most people aren't willing to do anything about it, but that we don't really know what to do. It is by now a familiar fact that the trillions of dollars Europeans have given to sub-Saharan Africans in food aid has produced even more hungry mouths to feed via explosive population growth. After many failed military adventures in the Middle East by the US and UK, many people are starting to acknowledge that we don't really know how to export institutions that promote endogenous economic growth. As Gregory Clark concludes in his majestic economic history of the world, 'History shows … that the West has no model of economic development to offer the still-poor countries of the world. There is no simple economic medicine that will guarantee growth'.[42]

Still, it is clear that many global challenges Persson and Savulescu emphasize, such as the spread of infectious diseases, are collective action problems that all of us have an interest in solving. And many of these problems require each of us do our part by making sacrifices, or supporting policies that force us to make sacrifices. Although Powell and Buchanan support research into *biomedical* moral enhancement, they think *cultural*

moral enhancement is much more likely to help us achieve the kinds of collective goals Persson and Savulescu discuss.

According to Powell and Buchanan, modern secular morality has developed norms and institutions that exhibit what they call an 'inclusivist anomaly'. The anomaly is that while morality originally served to maximize genetic fitness, and promote weak reciprocity, it has been extended to cover vulnerable people who cannot reciprocate with us on equal terms. Initially moral norms and moral emotions evolved to facilitate coordination between members of small groups, like contributing to a hunt or waging a war. But after many millennia something remarkable happened.

In recent years, Buchanan and Powell stress, the circle of moral standing has expanded. Beginning with the Enlightenment, and culminating with institutions that were designed after the two world wars of the twentieth century, the ideas of equal political rights within states and universal human rights across states began to spread. According to Powell and Buchanan, 'contemporary human morality is far more inclusive and non-strategic than evolutionary theories of morality would predict'.[43] One of the most striking features of this 'inclusivist anomaly' is that formal laws and informal norms extend rights not only to people of different races and religions, but also to animals who are incapable of reciprocating in the way humans can. These ideals are not always enforced, and they are clearly fragile. But as an anthropological observation, Powell and Buchanan are correct.

The debate is over whether these institutions can further extend our abilities to cooperate in ways that Persson and Savulescu hope, or whether we have reached our limits. Powell and Buchanan are cautiously optimistic about our institutions, while Persson and Savulescu argue that we may

need to genetically enhance our children in ways that make them better people. Ultimately, I think this is an empirical question, and the dispute is not as deep as it seems: both parties agree that we need more research before attempting to use biomedical means to morally enhance our children.

Some argue that we are beginning to revert back to more tribalistic political arrangements. While this is concerning to some, the main issue is whether groups cooperate across borders on issues of mutual concern. The goal of moral enhancement is to accomplish joint goals that each person or nation lacks the ability to solve on its own, including the control of communicable diseases and nuclear weapons. It is an open question whether the best way for our descendants to cooperate on mutually agreeable terms is to alter their children or their political institutions. The mundane answer is probably 'both', and that we really don't know yet.

Perhaps the most important thing we can do to promote the existence of morally motivated future people is to inform prospective parents about the benefits of strong reciprocators to human institutions, and the vulnerability of strong reciprocators to exploitation by weak reciprocators and people with very low levels of empathy. There are no guarantees they will listen. But unless we understand the social dynamics of our moral dispositions, and the trade-offs associated with manipulating our biology, biomedical moral enhancement is likely to be ineffective in our quest to make better people.

NOTES

1 Buchanan and Powell, *The Evolution of Moral Progress*.
2 Douglas and Devolder, 'Procreative Altruism'.
3 Hatemi *et al.*, 'Genetic Influences on Political Ideology'.

4 Douglas, 'Morla Enhancement'.
5 Persson and Savulescu, 'The Perils of Cognitive Enhancement and the Urgent Imperative to Enhance the Moral Character of Humanity'.
6 Zak *et al.*, 'Oxytocin Increases Generosity in Humans'.
7 Crockett *et al.*, 'Serotonin Modulates Behavioral Reactions to Unfairness'.
8 'Altruism' has been used in many different ways (Clavien and Chapuisat, 2013). I will equate generosity and altruism, and use both to indicate a person's desire to help others even when he believes there is no benefit for himself. Of course, we may be wrong about whether helping someone actually benefits us, and we may have mixed motivations, but the kind of altruism I have in mind is what some call 'psychological altruism' to indicate that it involves a *motivation* to help others, even at a net cost to oneself.
9 Edele *et al.*, 'Explaining Altruistic Sharing in The Dictator Game', p. 100.
10 Declerck *et al.*, 'The Effect of Oxytocin on Cooperation in a Prisoner's Dilemma Depends on the Social Context and a Person's Social Value Orientation'.
11 DeDreu *et al.*, 'The Neuropeptide Oxytocin Regulates Parochial Altruism in Intergroup Conflict among Humans'.
12 Prinz, 'Against Empathy'.
13 DeDreu *et al.*, 'Oxytocin Promotes Human Ethnocentrism'
14 DeDreu *et al.*, 'The Neuropeptide Oxytocin Regulates Parochial Altruism in Intergroup Conflict among Humans', p. 1411.
15 Declerck *et al.*, 'The Effect of Oxytocin on Cooperation in a Prisoner's Dilemma Depends on the Social Context and a Person's Social Value Orientation', p. 806.
16 Powell and Buchanan, 'The Evolution of Moral Enhancement', p. 252.
17 Zilioli *et al.*, 'Testosterone, Cortisol and Empathy: Evidence for the Dual-hormone Hypothesis'.

18 Baron-Cohen, 'Two New Theories of Autism: Hyper-systematizing and Assortative Mating'.
19 Tuvblad *et al.*, 'The Heritability of Psychopathic Personality in 14 to 15 Year Old Twins'; Tick *et al.*, 'Heritability of Autism Spectrum Disorders'.
20 Baron-Cohen, *Zero Degrees of Empathy*.
21 Savulescu, 'Procreative Beneficence'.
22 Douglas and Devolder, 'Procreative Altruism'.
23 Persson and Savulescu, 'The Perils of Cognitive Enhancement and the Urgent Imperative to Enhance the Moral Character of Humanity'.
24 Trivers, 'The Evolution of Reciprocal Altruism'; Axelrod, *The Evolution of Cooperation*.
25 Bowles and Gintis, 'The Evolutionary Basis of Collective Action'.
26 Binmore, 'Why do People Cooperate?'
27 Fehr and Gachter, 'Altruistic Punishment in Humans'.
28 Bowles and Gintis, 'The Evolutionary Basis of Collective Action'.
29 The proliferation of weak reciprocators would pose an existential threat to strong reciprocators over the long run. This seems especially true in a society in which people freely flow across borders and throughout large and anonymous cities, and thus suffer fewer consequences than they would in circumstances in which the reputation as a cooperative or an exploitative type would follow them.
30 Oakley *et al.*, *Pathological Altruism*.
31 Harris, 'Moral Enhancement and Freedom', p. 110.
32 Harris, 'Moral Enhancement and Freedom', p. 104.
33 La Rochefoucauld, *Maximes*.
34 Nietzsche, *Beyond Good and Evil*.
35 The term 'Ulysses contract' refers to the fact that the mythical Greek ship captain, Ulysses (the Romanized name of Odysseus), ordered his crew to tie him to the mast of the ship, blindfold him, and put wax in his ears, so that when they sailed by the island of the Sirens, the sound of their voices and beauty of their faces wouldn't lead him to veer off course.

36 DeGrazia, 'Moral Enhancement, Freedom, and What We (Should) Value in Moral Behavior'.
37 Dawkins, *The Extended Phenotype*.
38 Moller, 'Justice and the Wealth of Nations'
39 Ridley, *The Rational Optimist*.
40 Clark, *A Farewell to Alms*.
41 Frankfurt, 'Equality as a Moral Ideal'.
42 Clark, *A Farwell to Alms*, p. 373,
43 Powell and Buchanan, The Evolution of Moral Enhancement', p. 244.

Pretty People

3

The most beautiful of all Greek deities was Aphrodite. She was often depicted in the nude, and was almost always accompanied by Eros, god of sexual desire. Beauty and sex may be closely associated in many cultures because – if Darwin is right – our aesthetic sense originated in part from the ways in which we evolved to show off and appreciate the traits of potential partners.

There is a reason that actors who appear on television and in movies are beautiful, and that radio and podcast hosts have soothing voices. Looking at a beautiful face, and listening to a sultry voice, elevates our spirit and seems to give the message more credibility. It is well known in psychology that for most people deep voices and tall bodies convey authority, especially in men. The precise reasons for this are shrouded in our evolutionary history, but the fact remains: we enjoy being in the presence of beautiful people and hearing beautiful voices.

People go to great lengths to look good. We spend money and time on fitness, clothing, cosmetic surgery, hair, and makeup. We delete ugly pictures and apply filters to make our best photos look even better. It is also common to lie about age, weight, and height on dating apps. We lie to ourselves and to other people in order to send a message to the world that we are beautiful, or at least not ugly.

DOI: 10.4324/9781003464266-3

On the one hand, aesthetic enhancement could make us more honest, since we'd have less to lie about if we had fewer imperfections. On the other hand, if beauty is mostly relative, the pursuit of aesthetic enhancement by everyone may be collectively self-defeating since it would just change the average, or move everyone closer to a new average. And if there's a cost to improving our appearance, or some risk associated with editing embryos to increase our children's physical beauty, maybe it's not worth it. Maybe we'd be better off ignoring aesthetic considerations when choosing our children's traits.

ORIGINS OF BEAUTY

Ever since Charles Darwin published his theory, biologists have connected our sense of beauty with the ornaments we evolved to display and appreciate during courtship. In *The Descent of Man, and Selection in Relation to Sex*, Darwin vividly describes how beauty evolves via female choice:

> I know of no fact in natural history more wonderful than that the female Argus pheasant should appreciate the exquisite … ornaments and the elegant patterns on the wing-feathers of the male. He who thinks that the male was created as he now exists must admit that the great plumes, which prevent the wings from being used for flight, and which are displayed during courtship and at no other time in a manner quite peculiar to this one species, were given to him as an ornament. If so, he must likewise admit that the female was created and endowed with the capacity of appreciating such ornaments. I differ only in the conviction that the male Argus pheasant acquired his beauty gradually, through the preference of

> the females during many generations for the more highly ornamented males; the æsthetic capacity of the females having been advanced through exercise or habit, just as our own taste is gradually improved.

Darwin then extends this logic to cover other sexually reproducing species, including people:

> Everyone who admits the principle of evolution, and yet feels great difficulty in admitting that female mammals, birds, reptiles, and fish, could have acquired the high taste implied by the beauty of the males, and which generally coincides with our own standard, should reflect that the nerve-cells of the brain in the highest as well as in the lowest members of the Vertebrate series, are derived from those of the common progenitor of this great Kingdom. For we can thus see how it has come to pass that certain mental faculties, in various and widely distinct groups of animals, have been developed in nearly the same manner and to nearly the same degree.[1]

In this remarkable passage, Darwin summarizes the argument that some of the traits we place so much importance on were *sexually* selected, rather than being transmitted simply because they helped us find food, or fight off predators and parasites. In other words, Darwin traces the origin of beauty to sexual selection, rather than natural selection,[2] and endows non-human animals with an aesthetic taste.

Darwin believed females in many species favor males with traits they consider *aesthetically* beautiful, not merely useful. According to the mathematical biologist Ronald Fischer,[3] sexually selected traits often begin as honest signals of

underlying qualities like health. But, he argued, traits initially favored as honest signals of success in a particular environment can become independently favored by females who find them attractive even if they fail to indicate anything at all. A hypothetical example is a bright spot on a bird signaling that the bird can find specific nutrients necessary for health. A female preference for bright colors can, after many generations, become so strong that it leads males to evolve increasingly exotic plumage. Many birds have also evolved courtship dances that they perform in elaborate structures (or 'bowers') that they create specifically for seducing females. Building bowers may begin as a signal by males to females of a capacity for defense.[4] But color seems to matter as much as structure. Australian bower birds, for example, meticulously decorate complex bowers with bright blue objects to lure females who find them beautiful. Other bower birds have different but often equally colorful displays. However these displays began,[5] the female preference for them seems to be an example of runaway sexual selection, as the colors get brighter and the bowers more exotic.

In humans, male height may be an example of runaway selection. Women have a strong preference for tall men, though the preference seems to be for *taller than average* rather than extremely tall men[6] Height may have begun as an honest indicator of physical abilities like hunting or the ability to fight off aggressors, but may now be an example of runaway selection (albeit nowhere near as extreme as a peacock's tail or a bower bird's nest).

By contrast, facial symmetry, which is aesthetically desired by both men and women, may be an honest signal of a low mutation load, low oxidative stress, or a low parasite load. Mutations accumulate every generation and, in the absence

of purifying selection, can add up to significant fitness costs.[7] Indeed, according to Geoffrey Miller, 'sexual reproduction probably arose as a way to contain the damage caused by mutations'.[8] William Hamilton proposed (and Miller agrees) that sexual reproduction evolved at least in part as a defense against parasites, so that by shuffling the genetic deck every generation our immune system can keep up with the evolution of deadly microbes.[9] And a number of authors have traced facial asymmetry and premature aging to the oxidative stress that occurs when free radicals escape during cellular metabolism (Lane, 2004). If any of these theories are true, traits we find beautiful are to some extent an indicator of genetic health.

In fact, Amos Zahavi famously proposed that even extreme ornaments like peacocks' tails and bowers' nests are costly signals that indicate fitness rather than reflecting the haphazard aesthetic preferences of females.[10] In effect, costly signals indicate that a male is so powerful he can afford to be hampered by useless plumage or a body size larger than it needs to be to hunt efficiently. If Zahavi is right, even runaway selection is not capricious, and beauty is not arbitrary. Traits that we think of as beautiful may be honest signals of underlying fitness.

Darwin and his contemporary defenders disagree.[11] On Darwin's view, sexual selection can become so divorced from natural selection that it can drive a species into extinction. Beauty can be a false signal, or it can be nothing other than a trait that females happen to find attractive, even if it originated in the need to decipher genetic quality.

Why does the *origin* of beauty matter for the ethics of genetic enhancement?

First, whatever their origin, standards of beauty for a given species tend to be fairly universal, even if different subspecies have different standards.[12]

Second, as indicated above, beauty often correlates quite a bit with overall health and vitality (low parasite load, low mutation load, etc.). This suggests that some aesthetic enhancements will actually improve our health. And the converse is also true: some improvements to our health – for example, editing or selecting out deleterious mutations – will also improve our aesthetic appeal. It could do this by making our faces more symmetrical, or by making us more clever, which is attractive to both men and women.

Finally, the evolutionary origin of beauty strongly suggests that pursuing some kinds of aesthetic enhancements may be collectively dangerous, even if they are individually rational. Runaway selection vividly shows how individual choice and collective welfare can come apart. It can magnify traits that are good for all (e.g. intelligence and kindness), or traits that are good for *each* but bad for *all* (e.g. the peacock's tail or male height, to the detriment of health).

FROM CRYPTIC CHOICE TO CONSCIOUS SELECTION

When parents intentionally create children (rather than having them as an accidental byproduct of sex) they tend to think about which traits will make their children happy, rather than which traits will maximize their reproductive potential.[13] Of course, there is some correlation between fecundity and attractiveness since our sexual appetites and relationship preferences evolved to track traits – like health, strength, and intelligence – that would make it more likely that our children would survive and reproduce. But the correlation is imperfect. This is true in part because runaway sexual selection can sever the tie between what's beautiful and what's useful, or conducive to happiness. But it's also true because the mating market constrains our options much more than the fertility clinic,

and because what we find desirable in a partner may differ from the traits that we think will benefit our children.

In the fertility clinic, women seem to select traits that they think will lead their children to live a prosperous life. Like men, women care about aesthetic beauty quite a bit, but women consider beauty less important than intelligence and character. We can glean this information from a number of sources. One is to do surveys and ask people what traits they value in long-term mates, and what they want their children to end up like. Another is to observe mate choice through dating patterns, or examine what traits women value when they shop at sperm banks. As economists like to say, actions reveal preferences.

Preliminary evidence suggests that both women and men value kindness, attractiveness, easy-goingness, and intelligence in long-term mates.[14] For some traits, such as intelligence and easy-goingness, women seem to find men increasingly attractive up to about the 90th percentile in the population from which a choice is being made. Beyond that, attraction plateaus, and even declines to some extent. There appear to be threshold effects. This may be because overly kind people are seen as insufficiently ambitious, and exceptionally bright people are sometimes thought to be socially inept.

According to a recent study, when women select male sperm donors, they care a lot about education, and to a lesser extent income. Education and income presumably indicate intelligence and social success.[15] They also care about the looks of their donor, but less so than intelligence and personality. Since very few men shop around for eggs, we don't have analogous data. But we do know that while men seeking long-term partners care about youthful good looks, they also

look for general fitness indicators like intelligence and kindness,[16] which are likely to lead to social success in diverse environments.[17]

But not all of the things we find attractive in a mate, or traits that we hope our kids will develop, are benign. Some kinds of aesthetic enhancement may be self-defeating, and others might be collectively harmful. Still others might be good for those who enhance, but bad for the unenhanced, and considered a source of unjust inequality.

Recall that cognitive enhancement seems to create some positive externalities for the unenhanced. This is because smart people are more likely to develop new technology, and are more likely to create prosperous societies because they are, on average, more cooperative and more patient. High average intelligence strongly predicts national prosperity, which benefits everyone, even if cognitive inequalities have some negative effects on those left behind. Although it's impossible to say for sure, the cost of inequalities may be compensated by the unintended benefits that accrue to those who have lower than average cognitive ability.

Aesthetic enhancement is perhaps less likely to confer aggregate social benefits than cognitive enhancement. Above some level, aesthetic enhancement may be collectively self-defeating, or even conceptually impossible if beauty lies along a bell curve such that for some people to have more, others must have less.

If this is true, although some aesthetic enhancement could increase beauty *and* aggregate welfare, we may hit a ceiling in terms of quantity and variety. Above that ceiling, more is *not* better, and may – for reasons discussed above – produce social costs. Aesthetic enhancement would then be a 'red queen' phenomenon, named after the scene in *Through the Looking Glass*

in which Alice notices that no matter how fast she runs, she stays in the same place relative to the red queen and everyone else around her.[18]

This suggests that, in principle, there are good reasons to regulate aesthetic enhancement once it hits a threshold in which improvements are just costly ways of trying to keep up with an average that keeps moving. Robert Frank has argued that sometimes taxing or banning the pursuit of luxury goods like cosmetic surgery is not only good for those who can't afford them, but also good for those who can.[19] The same argument can be applied to aesthetic genetic enhancements. The idea is that if everyone is free to pursue a positional good that we all recognize we'd be better off not pursuing, we would welcome restrictive regulations, provided they are enforceable and effective.

Suppose that we select for tall sons and curvy daughters, knowing these traits are considered both sexually attractive to potential partners, and likely to raise our kids' social status. We might do this because conventionally beautiful men and women are likely to earn more income,[20] and are more sexually attractive to mates than their less beautiful counterparts. It is conceivable that as we enhance these traits, preferences for them will also ramp up. Ronald Fischer showed that genes which code for a sexually selected trait are likely to be linked with those that tend to produce a preference for that trait in the opposite sex.[21] In the environments in which we now live, very tall people are more likely to suffer joint injuries (due to carrying a lot of extra weight), and may suffer unhealthy heart conditions (due to an increased ratio of body size to heart size). And women with large breasts may be more likely to suffer from back injuries, as well as having to carry around extra weight that isn't especially useful (shapely breasts have

no effect on breastfeeding, but instead seem to be purely sexually selected).

Despite the reasons we have to try to prevent aesthetic arms races through regulations, arguments in favor of the freedom to pursue aesthetic enhancements through genetic selection are strong.

First, there may be upper limits to some aesthetic positional goods. To take an example focusing on the body, men in all cultures are attracted to a fairly similar waist-to-hips ratio for women, and women are attracted to a similar shoulders-to-waist ratio for men.[22] To take an example from the face, men and women are attracted to both symmetry and averageness.[23] Once these are reached, different body ratios or more facial symmetry do not become more attractive. Even aesthetic features that appear to be purely positional goods, such as curviness in women and height in men, may not generate an endless arms race if there are health costs associated with enhancing them beyond a certain point. The kind of careful deliberation that would go into selecting embryos is unlikely to elicit the visceral attraction that occurs during courtship. Parents will presumably care more about their children's physical health and mental well-being than superficial traits.

Second, conventional cosmetic surgery is expensive and invasive, and some genetic enhancements might preclude the need to pursue certain kinds of aesthetic enhancements. As income goes up, many people spend more money on surgeries to erase wrinkles, chemicals to whiten teeth, and hair dyes to color hair. Genetic enhancement will eventually be safer and cheaper than cosmetic procedures to the extent that it might slow the aging process, or delay the onset of gray hair, muscle loss, and wrinkles. It might also produce a texture of hair or nose shape that is universally desired, which would

obviate the need for expensive hair treatments or dangerous cosmetic surgeries. Genetic enhancement, then, can reduce the health risks and financial costs associated with cosmetic surgery that future people might otherwise pay for.

Third, some traits that we consider unattractive are due to deleterious mutations. If we can select or alter embryos to minimize harmful mutations (even those not related to any particular bodily feature), beauty and health are likely to increase as a byproduct – especially for those with a relatively high genetic load.[24] Still, once this threshold is reached, it looks like continual efforts to enhance beauty – at least, *conventional* beauty – will be collectively fruitless.

Fourth, in a world in which information flows freely, and the cost of medical tourism decreases, regulations on aesthetic enhancement may be unenforceable. Parents will likely be able to access genetic information about aesthetic traits even if the information is censored by a specific country or medical association. People already travel to places like Mexico to save money on cosmetic surgery that they can't access in the United States, just as they travel to places like India to purchase a life-saving kidney. There is no reason to think they won't do the same thing to alter or select an embryo, given the massive potential benefits for their children.

Finally, although social norms may be less effective at influencing our reproductive choices if our choices are made in private, we could impose rules that make people's choices public, and thus subject them to social pressure that might come from health care professionals and others who might observe these choices. Shame might then be harnessed to disincentivize frivolous or dangerous aesthetic enhancement.

For all of these reasons, coercive regulations attempting to block the pursuit of aesthetic positional goods will

probably be superfluous or (mostly) ineffective. It is impossible, though, to say ahead of time whether this is true. More importantly, laws intended to block expensive arms races may exacerbate unfair inequalities. We've encountered this objection in previous chapters: regulations often prevent some people from accessing the goods being regulated, but permit the already powerful to use them. They do this by raising the relative cost of access, and by increasing the risks associated with black markets. When demand for a good is strong enough to create black markets, regulation meant to benefit everyone can inadvertently benefit the most powerful people, who are more likely to find ways around the rules than less powerful or wealthy people. Still, some regulations may be effective, especially if they are cheap to enforce, and if the benefits to violating them are not especially big.

AESTHETIC DISCRIMINATION

While aesthetic beauty can indicate genetic health, the correlation is quite loose, and many of us end up unfairly judging people on the basis of their attractiveness. According to Anjan Chatterjee, 'attractive children are considered more intelligent, honest, and pleasant, and are thought to be natural leaders'.[25] Taller men generally make more money and are thought to be more competent. The correlation is so strong that people who are thought to be powerful – Hollywood actors like Tom Cruise, or leaders like Winston Churchill – are assumed to be taller than they actually are.[26]

Some philosophers have termed this kind of discrimination 'lookism',[27] which may be compared with sexism or racism – the tendency to judge an individual on the basis of the average traits of their group. Whether or not we adopt this terminology – I suggest we don't since 'sexism' and 'racism'

are already overused terms – it is clear that aesthetic discrimination occurs in virtually every domain of life. Some of it may be justifiable, such as when we are seeking mates or hiring a model for a magazine or an actor for a movie. Other cases may be unjustifiable prejudice, such as assuming someone will be less competent simply because they have a big nose.

We all rely on heuristics in daily life, and we generalize on the basis of cases we've personally experienced. Heuristics and generalizations about groups often fall under the rubric of stereotypes. And, contrary to what influential elites in academia and journalism want to believe, many of our stereotypes are surprisingly accurate.[28] Moreover, acting on the basis of stereotypes can be rational when information is limited, even if it is sometimes morally questionable. For example, if you are walking down a dark alley, you may find yourself more afraid of a 20-year-old man than a 60-year-old woman who is moving toward you. This fear may be misplaced in any particular case, but it is often based on experience, and can be justified given the statistical likelihood of a young man or an old woman to commit some kind of violent crime. Statistical generalizations can sometimes be epistemically reliable and morally justifiable ways of narrowing down a pool of potential job applicants, mates, or partners on a sports team.

However, sometimes acting on the basis of stereotypes is morally wrong even when the generalization that underlies the stereotype is rationally justifiable. This is true when acting on stereotypes makes members of some groups much worse off than they would be if we judged them as individuals. For example, fear of a young man in a dark alley is rationally defensible and morally justifiable. Using aesthetic attractiveness to assess the competence of an applicant for a job as a radiologist is not. In the case of aesthetics, it may be difficult

to avoid making judgments about people. But given the devastating consequences of constantly being judged badly simply on the basis of our looks, we have strong moral reasons to encourage compassion toward people who are regarded as ugly.

We should also protect them against egregious forms of discrimination at work and at school by cultivating norms of respect and, if needed, legal restrictions against certain kinds of aesthetic discrimination. This is not to say companies should be forced to hire unattractive people to advertise their cosmetic products, or that employers can't have standards of hygiene or decorum for their employees. But it does seem like we should permit people to sue for unjust discrimination if they have conclusive evidence that they were fired or otherwise mistreated simply on the basis of their looks, when beauty isn't central to their job performance.

Nevertheless, the most effective response to discrimination on the basis of mere looks may be to empower parents to select embryos that will minimize extreme asymmetries and physical deformities. Disability advocates sometimes emphasize that this response fails to deal with the underlying problem, which is unjust discrimination. They have a point. Sometimes we should change our reactions toward other people, especially when those people cannot change their appearance or abilities. We can also change our environments in ways that make it easier for people to navigate, such as building ramps for wheelchair access. These are not mutually exclusive: we can teach tolerance and make it harder to act on our biases; we can improve the environment for people with certain kinds of disabilities; and we can intervene with genetic technology to minimize the extent to which disabilities create personal or social costs.[29]

INEQUALITIES AND ARMS RACES

So far, I have argued that universal access to aesthetic enhancement might be paired with attempts to encourage compassion and impose laws meant to reduce unjust aesthetic prejudice. But this does not solve the more fundamental problem that inequalities of beauty may be an inevitable part of ordinary human life, and the lives to come when genetic enhancement technologies become ubiquitous.

Robert Sparrow argues that parents who attempt to genetically enhance their children will impose relative costs on those who opt out.[30] In the case of aesthetic enhancement, this might mean exacerbating the aesthetic inequalities that exist now. But unless we take where we are now as morally special, we can turn Sparrow's argument on its head and use it to defend universal access to genetic technologies that foster aesthetic enhancement. If inequalities are likely to increase when some choose to genetically enhance their children and some don't, this may be a reason for everyone to enhance rather than for everyone to refrain. Of course, there will be inequalities either way. But not all inequalities are unjust.

If a parent can easily alleviate a condition like low intelligence, disability, or ugliness through genetic selection, but refrains from doing so out of a sense of allegiance to an abstract egalitarian principle, this may be an argument against the principle rather than a reason to restrict using genetic technology for aesthetic (or other kinds of) enhancement. Failing to use genetic technology when it is safe and cheap, and when it is unlikely to be collectively self-defeating, may eventually constitute criminal negligence.[31] Refraining from a safe and beneficial genetic enhancement may be on a par with parents refusing to allow their child to be vaccinated

against an infectious disease simply because not everyone in the world has the same opportunities.

There may be reasons to try to spread access to scientific and health innovations to all. But this does not mean that those who can afford such opportunities should be forced to forego them until everyone else has the same opportunities.

There will always be differences in access to goods, and sometimes this is a necessary consequence of an efficiently functioning market. In a market system, where private property and free exchange are protected, those with more wealth or risk tolerance buy new products first. This allows the product to be evaluated for safety, and to become cheap enough through mass production that those with less wealth or more risk aversion can eventually enjoy it. There is no principled difference between automobiles, clothing, or genetic enhancement procedures. The morally salient fact about enhancement technologies is that they will allow large inequalities of ability to emerge quickly, which is more troubling than inequalities in access to designer clothes or exotic food. Inequalities in intelligence or beauty could lead to more discrimination against the unenhanced, and a general level of contempt by the able toward the unable (assuming moral enhancement doesn't mitigate this).

This is one reason to support the dispersion of a basic tier of enhancement technologies via government subsidies.[32] Subsidies are unlikely to fully solve the problem of a transition period during which some have access to transformative technologies, while others are left behind. To solve this problem, some argue that essentially *all* enhancement technologies should be made available as a matter of public health.[33] But given the fact that new (and presumably patented) innovations will be expensive to subsidize, providing immediate

universal access would be *controversial* in many rich countries and *impossible* in poor countries. The reason it would be controversial at best, and impossible at worst, is that there is an innovation vs. access trade-off with new technologies, and there is legitimate moral disagreement about which should have priority in any particular case. The trade-off results from the fact that allowing rich people to invest in products that may eventually benefit everyone speeds up the production of those products. But equalizing access typically involves coercively taxing wealth or productivity in order to subsidize the availability of certain goods or procedures for everyone else.

When it comes to aesthetic enhancement, very few people will think it's worth subsidizing universal access to every new discovery about how to edit or select embryos to create prettier people. As I've argued, beyond some basic aesthetic improvements – especially those that correlate with genetic health – a lot of aesthetic improvement is likely to involve chasing positional goods of relative beauty. And in these cases, especially, subsidies would be collectively self-defeating, even if access to a basic tier of aesthetic enhancement can be morally justified.

NOTES

1 Charles Darwin, *The Descent of Man*, chapter 21.

2 Darwin construes *natural* selection as being a filter that favors traits like a healthy immune system to fend off parasites, a thick shell to protect against predators, a muscular frame to lift heavy objects, or a thin frame to move more quickly. But Darwin thinks of *sexual* selection as a separate and sometimes opposing force. Sexual selection is primarily driven by females, especially in polygynous species, because they produce fewer eggs than males, and because they often bear disproportionate

costs in raising offspring. This gives females an especially strong reason to be choosy. Some contemporary biologists have combined natural and sexual selection into a single equation, but as Richard Prum (2017) argues, this obscures Darwin's claim that the two can be *opposing* forces that pull in different directions, not merely complementary ones.

3 Fisher, 'The Evolution of Sexual Preference'.

4 Borgia, 'Why do Bowerbirds Build Bowers?'

5 There is some dispute about whether the displays ever indicated anything useful to females. According to ornithologist Richard Prum, given the easy availability of the materials used in bird displays, 'there is no compelling evidence that bower decorations are costly, honest signals of male quality. Rather, they appear to vary like any other aesthetic styles among species' (2017, p. 197).

6 Ellis, 'The Evolution of Sexual Attraction'; Courtiol *et al.*, 'Mate Choice and Human Stature'.

7 It is important to note that 'fitness' is deeply ambiguous. Darwin uses it in a fairly conventional way, as an indicator of health, strength, and vitality. But many mathematical biologists have redefined it in such a way that it is trivially true that fitter animals survive. The reason is that some use 'fitness' to indicate reproductive success, along with health and other qualities that predict the ability to survive in a particular niche by finding food, fighting off parasites, and (in some species) figuring out how to navigate a complex social environment.

8 Miller, *The Mating Mind*, p. 101.

9 Hamilton *et al.*, 'Sexual Reproduction as an Adaptation to Resist Parasites'.

10 Zahavi, 'Mate Selection—A Selection for Handicap'.

11 Prum, *The Evolution of Beauty*.

12 Chatterjee, *The Aesthetic Brain*.

13 The title of this subsection is an allusion to the concept of cryptic female choice, which occurs when females behave in ways,

outside of sex, that influence their chance of pregnancy. For example, in some species females can excrete hormones that lead to an early termination of pregnancy, and in others, females can store the sperm of different males and then later select the highest quality among them (Eberhard, 1996).

14 Gignac and Starbuck, 'Exceptional Intelligence and Easy-Goingness May Hurt Your Prospects: Threshold Effects for Rated Mate Characteristics'.

15 Whyte *et al.*, 'What Women Want in their Sperm Donor'.

16 Miller, 'Mutual Mate Choice Models as the Red Pill in Evolutionary Psychology'.

17 Men care more about youthful looks than women do in searching for mates because male fertility only slowly declines with age, whereas female fertility drops precipitously after the age of 30 or so. These preferences seem to be baked into us (Ridley, 1993; Miller, 2000).

18 Ridley, *The Red Queen: Sex and the Evolution of Human Nature*.

19 Frank, *Luxury Fever*.

20 While beautiful people are clearly more likely to become actors, or succeed as models, some have questioned the widely held assumption that there is an overall wage premium to being beautiful, once intelligence and personality are taken into account (Kanazawa and Still, 2018).

21 Fisher, *The Genetical Theory of Natural Selection*.

22 Miller, *The Mating Mind*.

23 Chatterjee, *The Aesthetic Brain*.

24 'Genetic load' is the shorthand term for the number of deleterious mutations a person has. I've followed the convention in equating 'genetic load' with 'mutation load'.

25 *The Aesthetic Brain*, p. 31.

26 Chatterjee, *The Aesthetic Brain*.

27 Minerva, 'The Invisible Discrimination Before our Eyes', p. 17.

28 Jussim *et al.*, 'Stereotype Accuracy: One of the Largest and Most Replicable Effects in All of Social Psychology'.

29 Brock, 'The Non-Identity Problem and Genetic Harms'.
30 Sparrow, 'A Not-So-New Eugenics?'
31 Metzl, *Hacking Darwin*, p. 25.
32 Buchanan, *Beyond Humanity*, chapter 8.
33 Bognar, 'Enhancement and Equality'.

Healthy People

4

After being sentenced to death for corrupting the youth and denying the gods of the state, Socrates implored his friend Crito to make a sacrifice to Asclepius, the Greek god of medicine. Asclepius had the power to cure and even resurrect people, bringing them back from Hades to Earth. For exercising this power, Asclepius was punished by Zeus, perhaps so Zeus could keep the human population more compliant.

Mortality has always generated fear, and infectious disease has probably caused more suffering than almost any other force in nature. Infectious disease has also shaped social and political history. For example, when the Black Death was brought from Asia to Europe by Italian traders, some fanatics blamed Jews for casting spells on Christians. This caused some Christians, who lacked a germ theory of disease, to burn Jewish villages and murder tens of thousands of Jews in retaliation for a plague they figured Jews caused by hygiene rituals that were believed to protect Jews from the plague.[1] Infectious diseases like polio also shaped American history. When Europeans arrived in the New World, beginning with Christopher Columbus in 1492, they brought with them bacteria and viruses to which they had immunity, but to which the native population was susceptible. These included the bubonic plague, chicken pox, and influenza. These diseases decimated the indigenous populations. Similarly, Europeans

DOI: 10.4324/9781003464266-4

picked up syphilis from Native Americans and brought it back to Europe. The reason Europeans had more immunity from a variety of diseases they carried is because of trade: Europeans had contact with the Middle East, India, and China for many years, and thus swapped diseases – and immunity – with a diverse pool of people around the world. Native Americans were geographically isolated for up to 20,000 years, and thus lacked immunity to many diseases common to Eurasia and North Africa.

Disease exchange throughout history has *followed* trade and conquest, but it has also *enabled* it. Although people didn't really understand the nature of disease until the confirmation of the germ theory in the nineteenth century, some populations had an intuitive sense of what was going on. So much so that at various times armies have engaged in primitive biological warfare. For example, there is strong evidence that invading armies of Mongols hurled bodies infected with the plague into the city of Caffa (in Crimea) in order to transmit the disease and hasten their military conquest.[2]

This chapter will begin by considering genetic enhancements that improve the immune system against infectious disease, and end by raising some of the social implications of parents' ability to use embryo selection to reduce the risk of genetically mediated disease, ranging from cancer and heart disease to psychopathy and schizophrenia.

OPTIMIZING IMMUNO-DIVERSITY

Of all the topics covered in this book, immuno-enhancement may be the one that most clearly illustrates how a set of choices made to enhance *individual* welfare can yield a distribution of traits that is not optimal for *social* welfare. If each parent chooses embryos that make it more likely that their children

have genes that confer immunity to particular microbes that threaten the local environment, they might inadvertently create immuno-monocultures that make it easier for mutated microbes to decimate populations. As Chris Gyngell puts the point

> Individuals gain an immediate advantage when they have a phenotype that provides resistance to a disease present in their environment. However, if every individual in a population has this same phenotype, this may make the population as a whole more susceptible to future threats.[3]

A simple example involves the sickle cell trait. When children are born with one allele (genetic variant) of the trait, they exhibit resistance to malaria. But when they inherit the same allele from both parents, they produce abnormal (sickle-shaped) blood cells that create a variety of health risks. According to the recent report by the Nuffield Council on Bioethics

> The persistence of the recessive sickle cell trait … appears to be a consequence of its protective effect against malaria. Thus, although it causes serious disease in some cases, elimination of the trait from the population would probably have negative consequences at the population level if malaria were present. The value of genetic diversity is thus not limited to individual well-being, but to the human population as a whole and its susceptibility to disease.[4]

Indeed, humanity has a history of creating monocultures that devastate entire populations. We've never had the power to

deliberately reshape the immune systems of an entire population, but we have selected crops for properties we like, and in the process created monocultures that parasites more easily attack. History is replete with examples. Perhaps the most famous is the Irish Potato Famine in the 1840s, which led to mass starvation in Ireland, and a new wave of Irish immigrants to the United States. The famine occurred because a single variety of potato was planted, making it easier for the microbe *Phytophthora infestans* to wipe out the entire population of potatoes.

Many evolutionary biologists have argued that one of the main reasons sexual reproduction spread so widely among multi-cellular organisms is to combat infectious disease.[5] On this view, the main advantage of sex is that it recombines genes in ways that allow each person (or other sexually reproducing organism) some chance of surviving the constant threat of parasites. Parasites of all kinds have much faster life cycles than more complex organisms. Organisms have developed two ways of fighting this: an adaptive immune system, and sex. In fact, although our immune systems are *complex*, even bacteria have *adaptive* immune systems. One of the technologies mentioned in the preface of this book, CRISPR, is the main part of the bacterial immune system, which evolved to fight off parasitic viruses. CRISPR works precisely by sequencing the bacteriophage viruses that attack them and, if they survive, 'remembering' the virus's DNA sequence, and using this information to fend off or disable future viruses with a similar genetic structure. Adaptive immunity is powerful, and without it bacteria and complex organisms would be wiped out very quickly given the speed with which parasites like viruses can evolve.

Sex changes everything. The bacterial immune system may be complex and adaptive, but sexually reproducing species

can invent a greater variety of tools to deploy as part of their adaptive immune system. Bacteria reproduce much faster than us (as do most parasites), but when people reproduce, we can evolve more diversity more quickly by recombining half of our genes with another set of genes in every generation.

The evolutionary biologist Matt Ridley compares parasites and the immune systems that complex animals have with keys and locks.[6] Our immune system produces a variety of white blood cells which are tasked with finding parasitic viruses and bacteria, killing them, and storing the information in specialized antigens that are ready to attack if the same parasite re-enters the body in the future. Think of our immune cells as locks and parasites as keys. Locks are effective only for a limited time, since parasites evolve quickly and continually create new keys until they hit on one that that unlocks our cells. Once they find the right key for the right receptor, they are off to the races. Sex allows some of us to stay ahead of the parasites that are constantly evolving to exploit us.[7]

Many of the parasites that plague us are relatively recent companions. Agriculture brought with it a host of new diseases, including influenza viruses, which we picked up from the birds and pigs that we domesticated.[8] According to infectious disease specialist Dorothy Crawford

> most of the microbes that cause the classic acute childhood infectious diseases, such as smallpox, measles, mumps, diphtheria, whooping cough and scarlet fever, were originally exclusively animal pathogens that at some time in the past crossed the species barrier to infect humans.[9]

Parasitic worms and the bacteria that cause cholera were also more likely to infect sedentary populations than hunter-gatherers,

since they require a large and stable population. Many of these diseases are so new that it is unlikely that the parasites which cause them do us much good (it usually takes many generations to forge a mutualistic relationship with microbes that begin as parasites). Genetically altering our children so that they lack the receptors that allow influenza or malaria to attack them may create massive gains, and little if any downside. For now.

PREDICTING THE FUTURE

In the natural world, nothing is certain. We cannot know which threats will evolve among parasites given the randomness of mutation, the unpredictability of gene flow, and the speed with which microbes evolve. And we do not know what will happen if we try to rid our environment of all *potentially* dangerous microbes. This strongly suggests we should not make changes to our children's genomes that assumes a particular path that microbial – or human – evolution will take. Instead, as researchers do with influenza vaccines, the best we can do is use computer models to make predictions about the ways a particular microbe might evolve in the near future. There are simply too many possible genetic combinations among microbes, and interactions between species, to be able to make accurate predictions distant in time.

Moreover, even if we could precisely predict the future of microbial evolution, this would not give us a reason to wipe out all microbes that impose costs on us. Some microbes unequivocally benefit us, while others impose costs but also confer benefits that may exceed the costs. An example of a beneficial bacterium is *lactobacillus*, which is found in the vaginal tract of women and coats the skin of babies when they are born. These bacteria provide protection against hostile bacteria that might otherwise infect newborns. Some strands of E.

coli help us digest sugars that would otherwise remain stagnant in our gut (other strands of *E. coli* can make us violently ill). In a sense, any bacteria that don't harm us can be beneficial by crowding out other bacteria. But even beneficial bacteria can do tremendous harm when they find their way into the wrong part of our body, especially our bloodstream or urinary tract. So the idea that there are good and bad microbes, and that we can safely kill all the bad ones and save the good ones, is mistaken.

A lesson can be learned from the reckless use of antibiotics in the first few decades after they were discovered and mass-produced. Soon after penicillin was used, resistant strains arose. Alexander Fleming, who discovered antibiotics, warned that resistance would occur. He even went as far as to say that 'the thoughtless person playing with penicillin is morally responsible for the death of the man who finally succumbs to infection with the penicillin-resistant organism'.[10] The widespread use of antibiotics causes generalized resistance in bacteria, making treatments more expensive, and in some cases impossible. This process works because resistant strains of bacteria that survive a course of antibiotics proliferate and pass along genes that confer resistance to other bacteria.[11]

But apart from resistance, using broad-spectrum antibiotics that have the power to kill many different species of bacteria can kill beneficial bacteria, and can create the conditions for opportunistic pathogens to proliferate. For example, *Clostridium difficile* (*C. diff*) is a bacterium that hides out in our gut but which often multiplies in patients who have had prolonged doses of antibiotics. *C. diff* can produce life-threatening inflammation of the colon and is often very difficult to get rid of (the cure, like the cause, is antibiotics). Thus, attempts to

extirpate all bacteria in order to cure a specific infection can backfire. In some cases, it can produce a worse outcome than not using antibiotics at all.

Finally, we now have good evidence that the lack of certain parasites may trigger our immune system to mistake our body's cells for invaders, and aggressively attack them.[12] In fact, this seems to be the origin of some allergies and autoimmune disorders.[13] Consider, for example, parasitic worms like helminths. These worms typically give people anemia, which saps their energy, but they seldom lead to death. However, some parasitic worms also seem to lower the risk of autoimmune disorders and allergies if we are infected with them at a young age.[14] The idea is that since people co-evolved with various parasites, the immune system anticipates infection. So when the parasites never come, the immune system can overreact to proteins it 'perceives' to be parasites, but which are in fact our own cells. To some extent, allergies and autoimmune disorders are an overreaction to benign proteins that we consume (like nuts, eggs, or milk), while autoimmune disorders are an overreaction to the body's own cells (which it treats as invasive parasites). These disorders result from a combination of genetic predispositions and environmental cues: the absence of particular microbes activates an overreactive immune system.[15]

If exposure to certain microbes at critical developmental stages is essential for staving off autoimmune attacks, some might conclude we should reject immuno-enhancement outright. But this argument moves too quickly for a couple of reasons.

First, some – but not all – bacteria are worth keeping around. Before we decide whether altering our children's immune system is worth doing, we would need to distinguish

which of the microbes in our environment are mutualistic, commensal, and parasitic. Most bacteria we interact with are *commensal*, meaning that they may benefit from the food or shelter we offer them, but they neither harm nor benefit us. Other bacteria are *mutualists*, meaning that they provide us with benefits, such as breaking down complex sugars that we can't absorb, or synthesizing vitamins. *Parasitic* bacteria, by contrast, are those that make us sick: their livelihood comes at the expense of ours. While we should be careful not to use vaccines or genetic enhancement to prevent colonization by commensal bacteria, or mutualists, we may have good reasons to enhance ourselves and our children to protect against the parasites that cause cholera or bubonic plague, which offer no benefits.

Second, if many microbes provide us with a mixture of benefits and harms, we might decide between two options: either we should refrain from altering the immune system, or we should alter it in a way that precludes the need for a microbe to prompt the immune system to work properly. For example, although being infected with some parasitic worms lowers our risk of autoimmune disorders, there is nothing inevitable about this. We can either try to ensure that these parasites are present, or we might alter the immune system that co-evolved with these parasites so that it no longer needs to be prompted by them to avoid attacking the body's own cells.

Of course, this response could be dangerous unless we know what the downstream effects of immuno-enhancements are likely to be. The point is that the individual or population-level harms that might arise from immuno-enhancement isn't an automatic argument against it. Rather, as with other genetic alterations, it gives us reason for caution – especially caution

about altering entire populations by coercive rules – until we know a lot more about the interactions between specific aspects of our immune system and the particular microbes it has co-evolved with.

Some philosophers and social scientists invoke the 'precautionary principle' in cases of deep uncertainty. There are different versions of the principle, but in its strong (and original) form – developed in the context of environmental pollution – it says that if there are serious but unquantifiable risks associated with a new technology that alters the environment we should not use it. A weaker form of the precautionary principle holds that we should balance potential risks against likely benefits, and reject using the technology unless the benefits are demonstrable and large. The weak version is just a common-sense call for caution in the face of uncertainty. The strong version is implausible, since the risks of nearly all innovations are imperfectly understood. Abiding by the strong version of the precautionary principle would halt virtually all technological innovation.[16]

In the case of enhancement against infectious disease, the risks of doing nothing are serious: infectious diseases will continue to decimate populations unless we take some precautions *against* them doing so. While it's true that we should be cautious about making radical changes to our innate immune system, we should not assume that our bodies are optimized by evolution to deal with the microbes that our children will encounter. Microbes will continue to evolve, many of our infections are a function of environments we've created over the past few thousand years, and genes are not fine-tuned by a master engineer to suit us under the variety of environments our descendants will populate.

The first genetically enhanced children were born in China, using techniques developed in the United States at Berkeley, Stanford, and MIT. In the Western world, strong laws and social norms prevent scientists from using CRISPR to edit human embryos intended for conception. While prohibitive laws also exist in China, Chinese scientists are under less scrutiny than Americans and Europeans.

In 2018, Dr. He Jiankui claims to have used CRISPR to edit the CCR5 gene in the developing embryos of twin girls, whom he named Lulu and Nana. 'Silencing' this gene produces resistance to HIV, though the procedure was widely denounced because CRISPR often produces off-target mutations in other genes, and because the total effects of silencing CCR5 are still not known. In fact, just months after Dr. He's announcement, scientific studies began reporting potential side effects of silencing CCR5. These include protection against cognitive decline with neurodegenerative diseases,[17] but also a potential reduction in lifespan.[18]

It is easy to condemn Dr. He's experiment with immuno-enhancement because the kinks in CRISPR are not yet worked out, and because the total effects of CCR5 are unknown. But we can easily imagine cases in which we do know the total effects of editing a single gene or a cluster of genes that predisposes us to fight off an infectious agent. In cases for which there are no costs, or in which the total costs and benefits are known, genetic immuno-enhancement should be on the menu of options when parents are creating kids.

The ethics of infectious disease is complicated because everyone on earth can be both a victim and a vector for agents that inflict serious harm or even death on other people. When parents decide whether to immunize their children with

vaccines, there is always a risk that they will harm their child given the (extremely unlikely) chance that their child is allergic to a particular vaccine, or to the medium through which the inoculated microbe is delivered (e.g. egg proteins). But the benefits are often enormous, and they are shared not only by the child, but by others with whom he will interact.

Immuno-enhancements are analogous to vaccines, except that they involve altering the embryo to confer immunity rather than injecting inoculated microbes. In both cases, there are risks and benefits, and in both cases the beneficiaries include the individual and the broader community. The big difference is that edited embryos would presumably have their germline altered so that they also pass down the mutations to the next generation. This seems like a big moral difference between vaccines and gene edits.

But there are reasons to think the difference between vaccines and germline immuno-enhancements are not as big as they initially seem.

First, if the technology to edit embryos is safe and accurate in one generation, it's likely to be at least as safe for future generations to undo the changes made. Thus, if the microbial environment changes so that the edited gene is no longer desirable, or if some new side effect is discovered that makes the change seem undesirable, we might undo the change in the next generation. There may be damage done in the meantime, but there is nothing magical about genetic sequences: they are not locked in once we change them. Edits should be reversible.

Second, there may be cases in which we can edit a gene to produce immunity to a disease for which we don't have a vaccine. In cases like this, it may be worth taking on more risk than it would be if there were an equally efficacious vaccine.

For example, George Church suggests that genetically engineering universal resistance to all forms of influenza may be a good idea, since the flu virus doesn't seem to confer any benefits.[19] This might be done by targeting a set of receptors that many different kinds of viruses attach to.

In the first chapter, I introduced the principle of the least restrictive alternative. There I argued that in cases in which there are demonstrable social benefits to a particular cognitive enhancement, and few if any costs, we should find ways to get reluctant parents to select or edit embryos accordingly. I argued that it's better to rely by default on individual choice and social norms for parents to make the right choices for their children. But I also argued that if we do resort to force, we should specify our social goal clearly and take the least restrictive means available to achieve it.

One kind of case in which this might occur is when parents are choosing in a way that's beneficial for their child but which is collectively harmful when enough parents make the same choice. For example, some parents may opt out of vaccinating their child because they think enough others will vaccinate anyway, and because there is some financial cost and health risk associated with vaccination. Other parents believe vaccines are a conspiracy against the public, or part of a plan by the devil to thwart God's will or Nature's way. In the first case, the parents are making an epistemically rational calculation that may be collectively self-defeating.[20] In the second case, the parents are also making a judgment, based on a delusion, that may result in a very bad outcome for their child. In many cases, their action is part of a set of choices each one of which is unlikely to make much difference, but the set of which can have enormous social consequences. This is because vaccines are never perfectly effective for the

individual, and because the probability of each of us being infected by a microbe often depends on how many other people either have the disease, or have been vaccinated against it.

Scientists agree that we don't need to vaccinate everyone to eradicate an infectious microbe. We just need *enough* people vaccinated to achieve 'herd immunity'. In the case of common viruses like flu or smallpox, this typically involves vaccinating around 80–90 percent of a population.[21] Political philosophers tend to agree that because individual liberty and social cohesion are important, and because it is virtually impossible to get consent from every citizen before a policy change is made, states should employ the least amount of coercion possible to achieve a common objective. Thus, if we all benefit from an environment free of an infectious disease like measles, but we only need *most* people to be immunized against measles to achieve herd immunity, we might employ policies offering strong incentives for parents to vaccinate themselves and their children if this is likely to work.

Examples of policies that fit this criterion include allowing children to attend a school only on the condition that they've had the relevant vaccines, or imposing a lottery such that everyone has an 85 percent chance of being forced to vaccinate against a serious disease, provided the vaccine is effective and the disease is deadly.[22]It is worth emphasizing that, unlike vaccines for diseases like polio and smallpox – which killed hundreds of millions of people in the 20th century – the COVID vaccine developed in 2020 was not very effective. Nor is COVID deadly for children, even if it is deadly for the elderly and immuno-compromised. Another example of a minimally restrictive policy is a 'nudge', which involves rearranging our 'choice architecture' so that we are free to choose how we like, but we are led through suggestion or

manipulation to take a course of action deemed socially beneficial.[23] There are many problems with nudges, including the fact that they involve policymakers deliberately exploiting our psychological biases in order to achieve a particular social outcome. Nudges also rely on policymakers having enough knowledge and beneficence to know which social outcome we should be aiming at, which is often not the case.[24] But nudges do seem generally preferable to coercion to the extent that they allow people to opt out of the 'socially preferred' option without undermining a socially good outcome. An example of a nudge for vaccines is a government-sponsored information campaign that reminds parents of the benefits of vaccinating their children, or which forces physicians to explain the benefits of vaccination without forcing parents to vaccinate their kids. Alberto Giubilini has plausibly argued that many parents who have strong anti-vaccination beliefs are unlikely to respond to nudges like this.[25]

We can invoke the principle of the least restrictive alternative in the context of vaccination *and* immuno-enhancement. If the social costs of an infectious disease are high, and if we agree that parents don't have the right to opt out of a vaccination program because of the harm they might impose on their children or – through their children – on other people,[26] then we might force parents to *either* vaccinate their children *or* edit a developing embryo against the relevant infectious disease. When there is some uncertainty about the total effects of an edit, and if a vaccine can accomplish the same goal as an edit, it's good enough for parents to vaccinate their children. There is no need to force them to perform a more invasive procedure to achieve the same result.

This conclusion is consistent with principles endorsed by prominent bioethicists like Dan Brock. Brock argues that

states can legitimately limit the rights of parents in reproductive decisions in order to prevent harm to others, or to preserve a public good.[27] Public goods in the technical sense are outcomes that are non-rival and non-excludable (shared by all, and in equal amounts). But philosophers and economists typically use the term to cover *benefits* that are non-excludable, so that if I perform an act like picking up trash on the beach or vaccinating my child, the benefits accrue to everyone who would otherwise see the trash on the beach or potentially acquire a disease by interacting with my child.[28] In cases like this, we may require parents to preserve the public good of an environment that is free from the kinds of infectious disease that we know how to prevent. And, when vaccines aren't available and the safety and efficacy of an immuno-enhancement is demonstrated, some states might even justify restricting procreative liberty by forcing parents to edit embryos in order to promote or preserve herd immunity.

This result may sound morally dubious, but I think this is because we tend to conflate facts and values. In the current year, we don't know enough and the procedures aren't safe enough to justify forcing parents to edit embryos in order to give their future children an immuno-enhancement. But that doesn't mean we'll never get there. In fact, assuming we develop a safe and effective way for parents to ensure their future children don't acquire serious infectious diseases – for example, assume we devise a genetic tweak that makes us totally immune from viral infections – I think coercion would rarely if ever be needed. Assuming most parents are reproducing intentionally rather than accidentally, few of them would decline a procedure that would radically improve the lives of their children.

SELECTING AGAINST INHERITED DISEASE

Since its advent in the 1970s, in vitro fertilization has allowed parents to select against diseases caused by chromosomal abnormalities, such as Down syndrome, and against monogenic diseases, such as Tay Sachs. But parents can now request polygenic scores that indicate the risk that each embryo will be predisposed to various disease risks, both physical and mental. The more information they have, the harder the choices will get. But this is a good problem to have: parents with a family history of specific diseases – like breast cancer or schizophrenia – will be able to select against the diseases they worry about most.

Genetics plays a role in the development of virtually every disease that exists.[29] Although smoking makes it more likely that we will get lung cancer, for example, genes powerfully influence whether we end up developing the disease, even when we hold behavior constant. Genetic mutations in a region that influences the relevant biological system – circulation, skin, lungs – can make us more prone to developing or dying of a particular disease to which we're predisposed.

For example, Africans are more likely than Asians to suffer hypertension regardless of whether they are rich or poor.[30] And indigenous groups in North America, along with American mestizos – who are a mixture of Spanish and indigenous ancestry – are more likely to suffer type 2 diabetes even with the same diets of other groups.[31] The reason for this seems to be that different groups are adapted to different environments in which they now find themselves. Indigenous groups in the Americas do not seem to have developed the genetic capacity to regulate blood sugar levels to the extent East Asians and Europeans did after consuming lots of carbohydrates. So, in the modern world, having easy access to sugar

and wheat and rice has led to an explosion of diabetes in the Americas. It's important to notice that this isn't so much a genetic 'defect' as it is a mismatch between modern diets and ancient adaptations.

Evolutionary mismatch occurs when our bodies and brains inhabit niches they are poorly adapted to, usually because we've changed our environments so rapidly.[32] Apart from diabetes, obvious cases of mismatch include recent increases in addiction to potent drugs and pornography (which were impossible to obtain for most people until recently), as well as the depression and alienation that often comes from living in small apartments in large cities far away from our family and friends.

Diabetes is a good example of a trait that is both environmentally *and* genetically influenced. In fact, many diseases are like this. Even when there are group differences in susceptibility to disease, the disease itself is often caused by many small genetic variants combined with environmental factors like diet to influence an individual's likelihood of developing the disease.

Genetic selection will reduce the risks of specific diseases for children. In doing so, as genetic selection becomes more common, it will also reduce the prevalence of some diseases in the overall population. Many parents in affluent countries already use prenatal testing to select against Down syndrome. But parents who use embryo selection will increasingly pay careful attention to diseases that are especially common in their family, and their ethnicity (which can be thought of as an extended family).

For example, Tay Sachs is a protein folding disorder that damages the nervous system and leads to a short and often agonizing life. Ashkenazi Jews are especially susceptible. But

because Jews now screen potential partners (or embryos) for the variant that causes the disease, Tay Sachs has become quite rare. Embryo selection will have a similar effect on many diseases, including polygenic diseases ranging from cancer and heart disease to diabetes and hypertension. The only difference between these and Tay Sachs or Down syndrome, for example, is that the latter are *monogenic* disorders that someone either inherits or doesn't, whereas heart disease and cancer are more probabilistic and involve many genetic variants. Despite this difference, some *polygenic* disorders will also become less common in a population if enough people select against them.

Assume parents can access genetic testing for polygenic diseases. How will they make decisions when there are so many diseases to worry about? And how will they weigh the benefits of reducing disease risks relative to the benefits of increasing non-disease traits like cognitive ability or aesthetic beauty? If parents generate many embryos from which to select, it is unlikely that one specific embryo will score better on every dimension that parents care about. In this case, which traits will parents prioritize, and how will they choose?

TRADE-OFFS IN SELECTING AGAINST DISEASE

Suppose a couple has 10 embryos (or 100 embryos via IVG) sequenced by a company that offers 25 different predictors, including schizophrenia, hypertension, diabetes, height, and intelligence, among others. Parents want to maximize the chance that their child will live a happy and healthy life. How will they make their choice?

An obvious method, familiar from economics, is to do an expected utility analysis: assign probabilities to various outcomes emerging from different choices, and multiply these by the goodness or badness of those outcomes across multiple

traits. While this may seem like a strange way of selecting an embryo, we implicitly make decisions this way in many areas of life. For example, when we buy a car or a house, we balance many factors including price, aesthetics, neighborhood composition, nearby stores, transportation, etc.

Similarly, when we select mates (which influences what our children will be like) we seek someone who's healthy, bright, attractive, and compatible with us. Such people are considered beautiful precisely because their traits tend to increase the odds that our children will survive and flourish. A preference among men for post-menopausal women, or among women for physically weak men, will quickly be replaced by a preference for younger women and stronger men (although strength is less important and thus less favored by women in modern environments).

But as mentioned in the chapter on beauty, our evolved heuristics do not always line up with our intuitions about what we consider to be noble, or with what will promote the welfare of our partner or children in modern environments. Moreover, an expected utility analysis becomes increasingly difficult as the number of variables over which we choose increases. First, we have to compare what often seem to be incomparable values – for example, the value of a man's height against the likelihood of him getting dementia a few years earlier than another embryo which is predicted to be shorter but more resistant to dementia. Parents will disagree on how to make these trade-offs, even if social norms and evolved heuristics guide their choices.

Social norms crucially influence our preferences, and they do this precisely because they embody information that helps us economize on choice.[33] Rather than selecting from a limitless menu of options for how to behave, we evolved to identify

people with high social status and imitate their behavior.[34] Moral and political philosophers often make specific claims about how we should choose given a set of abstract principles. But given recent insights about human nature – especially how ordinary people's choices are powerfully influenced by social norms – philosophers should focus on how different kinds of political societies will tend to result in specific kinds of elites who favor certain kinds of social norms that lead people to make better or worse choices from a social standpoint. A decadent, low-trust society might emphasize selecting for superficial beauty and a disposition for Machiavellian deceit; a more noble, high-trust society will emphasize the value of intellectual and creative achievements, and a disposition for trusting and generous behavior.

Still, even when social norms structure our choices, people will disagree about what's valuable, and they will benefit from automating their choices to some extent. Hospitals, health insurance companies, and governments often use Quality Adjusted Life Years (QALYs) to inform who should receive organ transplants first, or how many resources should be spent to give someone a little more life. As crass as it may seem, when resources are scarce decisions have to be made about who will live and who will die. Sometimes these choices are easy: other things equal, a teenager should get a lung transplant before an 80-year-old. Other times these choices are hard: should we perform an operation to raise the chance that an elderly person will live a few more months? If operations were free, the answer would be easy, but when they involve scarce time and resources, there are opportunity costs that QALYs help us quantify.

More specifically, parents selecting among several embryos could use a 'polygenic health index' to guide their choice.[35]

Physicians or embryo screening companies can create an index that helps parents select an embryo that maximizes QALYs (quality adjusted life years) or minimizes DALYs (disability adjusted life years). These models, and the choices they inform, combine math and morality.

One complication with using a polygenic health index is that some diseases we care about will either be cured or ameliorated when our kids are older (consider HIV, which is now easily treated, even if it cannot yet be cured). Parents should care less about selecting against a disease that they have reason to believe will be treatable or curable in the near future. Since parents aren't experts in medicine, they might defer to predictions made by experts (or AI models) about the likely progress of medicine in their child's lifetime – about which diseases will probably be cured, and which won't. But they should still be free to choose according to their own values. Informed consent is a good legal standard even if it doesn't capture every important aspect of a complex moral choice.

A persistent theme of this book, however, is that, in the aggregate, individual preferences can create good or bad social outcomes. In the case of a polygenic health index, we can imagine the state caring about the collective upshot of our choices, since these will affect the costs that our children impose on governments, health insurance companies, and other people. Individual parents may also care: they may wish to base their choices in part on what they expect other parents to choose. If brown eyes are common, green eyes may become more aesthetically valued, for example. Some of these interdependent choices will be benign, such as eye color, while others will be of great social significance, such as sex selection. The moral and legal issues these problems raise

have been addressed in previous chapters. It is important to emphasize, however, that most traits parents select are likely to depend very little on what others choose: being bright and having a lower risk of cancer is good for my child no matter what everyone else chooses.

A more personal decision that parents will face – one without much social significance, but with great significance for the welfare of children – is raised by pleiotropy. Pleiotropy exists when a single gene or a combination of genes manifests as more than one phenotypic trait. A trivial example is the ABCC11 gene, which causes dry earwax and less underarm odor. We may want to select an embryo with a gene that makes it smell better, but we get dry earwax as a side effect. There's nothing especially good or bad about dry earwax, it's simply an example in which one trait is unintentionally selected for when another trait is intentionally selected.

It is possible that pleiotropy poses a special problem for genetically *editing* embryos before we know the total effects of the genetic variants we propose to edit. But these risks do not apply to choosing between whole viable embryos. There is no more risk in selecting embryos using polygenic scores than there is in selecting them using traditional preimplantation testing for common Mendelian disorders like Tay Sachs. In fact, the pleiotropy objection may be an argument *in favor of* using polygenic screening of embryos since the best evidence is that genetic selection against many diseases inadvertently selects against other diseases, not for them.[36] Some call this 'positive pleiotropy' since the net effect on a person's welfare is positive.

There will surely be cases in which selecting in favor of one trait will result in the existence of some other trait that

isn't desired.[37] But the fact that so many disorders correlate with one another, rather than with healthy traits, suggests that worries about pleiotropy can be overstated. Parents will generally do well by selecting against disease, since it is often the case that genes which predispose us to develop one disease also predispose us to develop others. By selecting against common diseases, we will generally be favoring positive over negative pleiotropy. This is another case in which eugenic selection is likely to have both individual and social benefits.

NOTES

1 Zahler, *The Black Death*.
2 Wheelis, 'Biological Warfare at the 1346 Siege of Caffa'.
3 'Enhancing the Species: Genetic Engineering Technologies and Human Persistence', p. 507.
4 Nuffield Council on Bioethics, Genome Editing and Human Reproduction, p. 11.
5 Hamilton *et al.*, 'Sexual Reproduction as an Adaptation to Resist Parasites'.
6 *The Red Queen*, p. 72.
7 The same principle applies to bacteria, which exchange genes in an asexual way that helps them generate genetic diversity and stave off viruses (van Houte *et al.*, 2016).
8 Greger, 'The Human/Animal Interface: Emergence and Resurgence of Zoonotic Viral Infections'.
9 Crawford, *Deadly Companions*, p. 60.
10 Fleming, 'Penicillin's Finder Assays Its Future'.
11 This occurs through a process called lateral gene transfer, which serves a function analogous to sex, but usually involves picking up stray bits of DNA from other bacteria, and from phage viruses. The 'plasmids' that bacteria exchange aren't integrated into bacterial chromosomes but help bacteria express properties that confer resistance to antibiotics in the form of thick cell walls, enzymes that degrade antibiotics, and efflux pumps that

dispose of antibiotic chemicals which happen to make their way inside bacteria.

12 Blaser, Missing Microbes: How the Overuse of Antibiotics Is Fuelling Our Modern Plagues.

13 Velasquez-Manoff, An Epidemic of Absence: A New Way of Understanding Allergies and Autoimmune Diseases.

14 Cooper, 'Interaction between Helminth Parasites and Allergy'; Finlay *et al.*, 'Induction of Regulatory Cells by Helminth Parasites'

15 Klenerman, *The Immune System*.

16 Sunstein, Laws of Fear: Beyond the Precautionary Principle.

17 Joy *et al.*, 'CCR5 Is a Therapeutic Target for Recovery after Stroke and Traumatic Brain Injury'.

18 Luban, 'The Hidden Cost of Genetic Resistance to HIV'.

19 Church, Regenesis: How Synthetic Biology Will Reinvent Nature and Ourselves, p. 8.

20 Epistemic rationality aims at truth, or justification given the evidence. Instrumental rationality aims at desire satisfaction, which may not always correspond with forming true beliefs. This is because beliefs can be placebos, so that forming false beliefs is sometimes instrumentally rational because it makes us feel better or makes our lives as a whole go better.

21 Crawford, *Deadly Companions*.

22 Brennan, 'A Libertarian Case for Mandatory Vaccination'.

23 Thaler and Sunstein, *Nudge*.

24 White, *The Manipulation of Choice*.

25 Giubilini, *The Ethics of Vaccination*.

26 Flanigan, *Pharmaceutical Freedom*.

27 Brock, 'Shaping Future Children'.

28 Anomaly, 'Public Goods and Government Action'.

29 Jackson *et al.*, 'The Genetic Basis of Disease'.

30 Spence and Rayner, 'Hypertension in Blacks'.

31 Cochran and Harpending, *The 10,000 Year Explosion*.

32 Lieberman, *The Story of the Human Body: Evolution, Health, and Disease*.

33 Ellickson, 'The Market for Social Norms'.

34 Henrich, *The Secret of Our Success*.
35 Widen *et al.*, 'Polygenic Health Index, General Health, and Pleiotropy'.
36 Tellier *et al.*, 'Embryo Screening for Polygenic Disease Risk: Recent Advances and Ethical Considerations'.
37 Lencz *et al.*, 'Utility of Polygenic Embryo Screening Depends on the Selection Strategy'.

Synthetic People

5

The Greek goddess Cassandra was cursed with the ability to predict the future without the ability to change it. As far as the distant future goes, we are all Cassandra. The laws of physics imply that the bleakest possible future awaits us: all living things – all conscious life – will cease to exist. Entropy ensures this. But how and when that will happen is partly up to us.

For some reason, dystopian novels like *Brave New World* are more popular than utopian – or even mildly optimistic – accounts of the future. Maybe a certain amount of pessimism is built into us: being predisposed to believe everything will turn out okay regardless of the choices we make is not a recipe for success. So it makes sense that we're the descendants of restless creatures with anxiety about the future. But if political stability can be maintained in at least a few productive countries, we have reason to believe technology will continue to advance, enabling genetic enhancements of the kind mentioned in previous chapters.

In this chapter, I'll review some reasons for short-term pessimism, mainly rooted in demographic trends, and some reasons for medium-term optimism. I'll begin by considering the moral consequences of the still remote (and perhaps unlikely) possibility that we'll be able to create people from scratch. I'll then discuss how the ability to radically reshape populations through genetic enhancement is likely to influence our

DOI: 10.4324/9781003464266-5

political institutions, opportunities, and lives. I'll end by asking why we should reproduce at all, and whether we should try to remain a single species.

CREATING FUTURE PEOPLE

In 2008, Craig Venter and his team in San Diego announced that they had created life from scratch. By 2010, they constructed the first self-replicating bacterial cell by reverse engineering an existing bacterium called *Mycoplasma genitalium*. At a press conference, Venter announced that 'This is the first self-replicating cell on the planet to have a computer for a parent'. By 2016, the third version of this cell was created, serving as a blueprint for a synthetic bacterium with the minimum number of genes needed to survive and reproduce.[1] The self-replicating cell they created is not impressive on its face. It doesn't do much, other than eat sugar and make copies of itself. But the feat is of one of the greatest achievements in human history, since it shows that we can reverse engineer life and build new kinds of life from chemicals that are easy to obtain.

The fact that the ingredients to build life are ubiquitous doesn't mean life is easy to create. But it *can* be created, especially when its steps are simplified and automated. Synthetic biology is a rapidly growing field that allows scientists to take amino acids and – with the help of the right lab equipment – transform them into strands of DNA called 'BioBricks' that can be used to alter or build organisms. The amount of information required to understand and build even the simplest self-replicating cell is enormous. So synthetic biology could not have emerged until chemistry, physics, and genetics had become mature sciences, and computation had become powerful enough to sift through vast amounts of data faster than people can. But it is here. Synthetic biology will transform our

world by giving us new kinds of food, allowing us to create new forms of life, and enabling us to transform into a new kind of creature.

It is conceivable, barely, that through a similar process we might direct a (perhaps artificially intelligent) machine to string together amino acids and build an embryo from scratch. The resulting cell could then be implanted in the uterus of a willing woman, or potentially incubated in an artificial womb. Artificial wombs have been extensively discussed, partly as ways of helping prematurely born children develop in a healthy way. But they are not necessary for constructing synthetic people: they would just save women the inconvenience of pregnancy. The real barrier is the staggering complexity of understanding and synthesizing the billions of base pairs that comprise a human genome, and creating the embryo from which an artificial person could develop. If the process became feasible, it's easy to imagine at least *some* women wanting to carry a synthetic embryo to term because they were interested in creating a child that way, or because they were paid to do so. This is not much different from women today who act as surrogates for a friend's baby, or who accept payment in order to be a surrogate for a woman who cannot conceive or simply prefers not to go through pregnancy herself.

One reason people might have synthetic children is that they could construct genomes from scratch that lack deleterious mutations and some of the genetic vestiges of viruses that afflicted our ancestors and that litter our chromosomes.[2] Another is that we might add genetic variants that enhance whatever traits we're interested in. We might even use this kind of technology to transmit the data for assembling people on other planets, in other solar systems, with bodies that are

better adapted for different conditions.[3] In this sense, humans could colonize other planets without leaving our own.

In principle, we could also create genetic replicas of ourselves on our own planet, or on other planets – assuming that people or some other form of intelligent life has colonized other planets, and would faithfully carry out our plan to create people in another place. *Synthetic* replicas would not be *psychological* replicas: they would share our psychological dispositions (because that they share our genetic code); but they would have very different experiences, and end up as quite different people.

Assume for the moment that all of this is possible. Sending plans for how to construct a particular kind of living thing from one place to another is technologically challenging. It presupposes a much deeper understanding of genomics than we have now, and it requires the relevant ingredients, a hospitable environment, and willing executioners of our plans. But it is conceivable, and it violates no laws of physics that we know of.

Would we want to do this? I can't answer for everybody, but I think many people would. We might see it as a kind of immortality, although we would lack any psychological connection to a genetic replica of ourselves born somewhere else. We wouldn't suddenly wake up in a new body in a different place. Replicas would instead function like a twin born in a different time and place. We might see replicas, or edited versions of them, as a kind of survival in the sense that parents live vicariously through their (genetically related) children. We all wish our lives went different at various stages, and many people seem to take joy in thinking of their kids as versions of themselves who might learn from their parents' mistakes. There is nothing wrong with living vicariously. It isn't

immortality, exactly, but it's similar in some ways. And if we generate enhanced versions of ourselves we would be conferring benefits on another person that would presumably make their lives go better.

REPRODUCTIVE RIGHTS AND RESPONSIBILITIES

Would there be a *right* to have children in a world in which we could create many copies of ourselves at very low cost? In the world we live in now, procreative rights are often taken for granted. Because resources are limited and the cost of having a child is high, most people simply don't ask the question. They just *assume* we have an unlimited right to reproduce. But the idea of a boundless reproductive right is misguided.

In their pioneering book on genetic justice, *From Chance to Choice*, Allen Buchanan and his co-authors argue that:

> significant portions of the costs of having children are externalized in virtually all societies – that is, borne by others besides the parents (or children). The more this happens, the greater a claim these others might make to have some say in, or control of, the costs imposed on them.[4]

In many modern countries, these costs include medical care, education, child care, and welfare programs that involve coercively collecting tax revenue and redistributing it from those who earn more money to those who earn less. The response to this in future political societies may go in one of two directions: some political communities may want to decrease the extent to which we bear the consequences of one another's reproductive decisions, perhaps by repealing social welfare programs. Others may want to retain a society with more

socialized resources, but encourage some people to reproduce more and others to reproduce less than they would if left to their own devices.

Indeed, genetically enhanced people might provide such large social benefits that the citizens of some political communities would be willing to compensate people with widely admired traits for having more kids. Just as the costs of reproduction are often socialized in communities that share institutions and resources, so too are the benefits, and we all might benefit tremendously if there were smarter, kinder, more attractive people in the population.

While paying people to have children may seem like we'd be turning them into reproductive machines, surely some people would be willing to do this for financial or reputational rewards. Some might even consider it a worthy sacrifice – especially if the people who emerge are a lot more likely to achieve great things, like creating new kinds of art and solving socially significant problems. One way this might happen is to reward women who bear children from embryos created from couples (or clones of individual people) who are widely admired for their virtues or accomplishments or aesthetic traits.

If women weren't willing to bear children for the state, perhaps some governments would force women to bear 'superior' children though a kind of reproductive slavery. We can imagine them using the kinds of methods that appear in science fiction stories like *Brave New World* to sift people into genetic castes and reproductive roles to which they do not consent. The prospect of dystopian government coercion is probably the most common ethical objection people have to the widespread use of genetic enhancement technologies.

However, the worry that any kind of enhancement or any amount of state coercion will lead to dystopian science fiction scenarios is not especially plausible: not all slopes are slippery. In fact, government coercion in the reproductive realm already exists in the form of legal bans on incest, the goal of which is to prevent genetic harms. There are also widely accepted norms that stigmatize reckless reproduction.[5] And as more is known about heritable diseases and polygenic traits, some might support measures that prevent parents from knowingly implanting embryos with serious genetic diseases, like Tay–Sachs. This could be done with information campaigns, stern advice from genetic counsellors, and (at the limit) prohibitions on selecting embryos with serious inherited diseases. Even if parents don't know the relevant genetic facts, they might be held responsible for creating 'wrongful life' if those facts *should have been* known, especially in a society with genetic counselling and easy access to information and technologies that allow us to select or alter embryos.[6]

Less starkly and more controversially, some might think parents should be barred from having children that are likely to have very low intelligence, poor self-control, or severely attenuated empathy. After all, these traits are not only highly heritable and likely to lead to a life of frustration for the child; they are also likely to lead the child to impose costs on others. In fact, a recent survey shows that people's attitudes toward coercive eugenics is closely tied to their perception of how heritable behavior is.[7] For example, support for sterilizing violent criminals increases significantly when people believe (correctly) that criminality is moderately heritable. The same goes for encouraging bright parents to have more children, and dim parents to have fewer,

when people believe that traits like self-control and aggression (which influence criminality) are highly heritable.

Parents in rich countries already face significant restrictions on how they can raise their children. They are required by governments to feed and educate them, vaccinate them, and provide them with shelter and supervision. Given these widely recognized responsibilities that kick in when parents give birth to a child, it is hardly a stretch to think we should also impose responsibilities before birth. As David Benatar argues, 'if it is wrong to inflict a hardship on an existent person then, barring any special considerations, it is wrong to inflict the same hardship on a future person'.[8]

The moral principle here is simple: procreative choices are wrong to the extent that they bring a person into existence whose life is expected to go poorly. 'Expected' is an important qualification, because no parent can know with certainty whether their child will exhibit a particular set of traits, even if they screen an embryo, ensure prenatal health, and raise the child with affection. Developmental noise – factors that are hard to predict or control – can affect the pathway from embryo to child, and genetic predispositions are not destiny. But parents can be blamed if they fail to take adequate precautions against a pregnancy that, given widely available knowledge, is likely to produce a child with especially grim prospects.

Most of us recognize that procreation brings special moral responsibilities with it. However, the move from morality to law can be hard to justify. There's a difference between recognizing a parent's moral obligations to refrain from drinking too much alcohol while pregnant, for example, and arguing that the state should enforce those obligations in a particular way. The same is true for genetic screening. For this reason,

while giving governments some ability to regulate reproduction may be wise, we have good reasons to be skeptical of governments that claim extensive power over people's reproductive choices.

DEMOGRAPHIC WORRIES

For at least the last century, rich countries have witnessed an astonishing pattern. As income and female education rise, fertility falls.[9] Fertility in the rich countries of Europe and East Asia has fallen so fast in the past few decades that many demographers now talk about a 'demographic winter'. The pattern that has emerged is this: as people become wealthier, they gain more opportunities to do intellectually stimulating and hedonistically satisfying things with their time, and they seem to care less about children. They also get sucked into careers that uproot them from relationships and community. Although the pattern began before the advent of the birth control pill in rich countries, reliable contraception and decreased religiosity seem to have played a role in changing social norms so that people could enjoy the pleasure of sex without the consequences of children. We hacked our biology and made it possible to bypass the natural point of sex. We changed our environment so that children were no longer needed to care for their parents in old age. We became less religious, which severed the link between marriage and children. And we created cute companion animals like dogs and cats, which provide some of the emotional satisfaction that would have previously been provided by children.

Social welfare programs provide enormous benefits, especially for the vulnerable who are temporarily unemployed, injured through no fault of their own, or born with congenital challenges for which they are not responsible. But robust

welfare programs have also changed social norms and altered patterns of reproduction. Even Charles Darwin worried that:

> With savages, the weak in body and mind are soon eliminated; and those that survive exhibit a vigorous state of health. We civilized men, on the other hand, do our utmost to check the process of elimination; we build asylums for the imbecile, the maimed, and the sick; we institute poor-laws; and our medical men exert their utmost skill to save the life of everyone to the last moment … Thus the weak members of civilized societies propagate their kind. No one who has attended to the breeding of domestic animals will doubt that this must be highly injurious to the race of man.[10]

The Nobel laureate Erwin Schrödinger echoed this concern in his groundbreaking lectures on the nature and origin of life in 1956. Schrödinger emphasized that evolution works by variation and selection, but that:

> this whole mechanism appears to be blocked in civilized man – in some respects even reversed. We are, generally speaking, not willing to see our fellow-creatures suffer and perish, and so we have gradually introduced legal and social institutions which on the one hand protect life, condemn systematic infanticide, to try to help every frail or sick human being to survive, while on the other hand they have to replace the natural elimination of the less fit by keeping the offspring within the limits of the available livelihood.[11]

Both Darwin and Schrödinger were deeply ambivalent about this, since social welfare programs clearly improve the

prospects of the most vulnerable portion of any population. A related but rarely appreciated phenomenon first discussed by another Nobel laureate, Hermann Muller, is the problem of rising deleterious mutation loads in modern populations.[12] Historically more resources would have led to more fertility, not less. This generated variation in a population and meant that natural selection would eliminate people with genetic mutations that led to poor eyesight, proneness to cancer, etc. But in rich countries, we can easily treat poor eyesight with surgery, glasses, and contact lenses. And we can treat childhood cancers and other disorders with at least a partly genetic cause with increasingly sophisticated medicine. This is an enormous boon for human health and welfare. But it also means that deleterious mutation load is increasing, which is a strong argument in favor of genetically modifying our children when the technology becomes feasible.[13]

Earlier we explored the metaphor of 'Chesterton's Fence', which holds that we shouldn't tear a fence down until we understand why it was built. But Chesterton also developed an opposing metaphor, which I'll call 'Chesterton's Post':

> Conservatism is based upon the idea that if you leave things alone you leave them as they are. But you do not. If you leave a thing alone you leave it to a torrent of change. If you leave a white post alone it will soon be a black post. If you particularly want it to be white you must be always painting it again... Briefly, if you want the old white post you must have a new white post.[14]

We may need to modify our children simply to stay where we are now, given the cumulative cost of novel mutations.

Apart from the risks associated with mutations, we've already seen that intelligence, empathy, and a constellation of traits that matter for human welfare are moderately to highly heritable, which implicates a partly genetic cause. We've also seen that average intelligence is a good predictor of social stability, and empathy is in many ways the foundation for morality. If the average level of either of these was to decline in a population it would not bode well. Charles Darwin recognized this in 1874:

> It is most difficult to say why one civilised nation rises, becomes more powerful, and spreads more widely, than another; or why the same nation progresses more at one time than at another. We can only say that it depends on an increase in the actual number of the population, on the number of men endowed with high intellectual and moral faculties, as well as on their standard of excellence.[15]

In other words, the welfare of groups depends both on the heritable traits of those who comprise them, and on the moral norms and political institutions that create social order. These facts are intertwined: culture is connected with and in many ways downstream from biology. Culture shapes us, but different kinds of people give rise to different cultures. For example, in the last few years scientists have discovered that the new kinds of societies to which agriculture gave rise changed human beings genetically. Agriculture and eventually small cities allowed for more inequality, and it often rewarded virtues like intelligence, patience, and other personality traits that enable people to flourish in conditions that require long-term planning.

But as the Industrial Revolution hit England and spread to the world, wealth skyrocketed, enabling the formation of a

robust welfare state. This allowed the children of people who were poor or sick or unemployed to survive and reproduce at much higher rates, and led to suppressed fertility by the rich and successful. Charles Darwin was dimly aware of this pattern, thanks to his cousin Francis Galton, who discovered key concepts in statistics, invented psychometrics, and founded the eugenics movement.

'Eugenics' has become a dirty word in popular culture because of its excesses in the early twentieth century, including forced sterilization laws in the USA and Germany (which were applied to the 'feebleminded' but sometimes also to epileptics and even sexual deviants). But a lot of the criticism of eugenics conflates what Galton and many modern academics in bioethics mean by 'eugenics' with how the Nazis misused it.[16] Moral grandstanding has become so common in connection with the word that journalists often use 'eugenics' to mean something like 'unjust coercion of innocent parents'. But Galton and Darwin would have rejected this, and so should we.[17] According to Leonard Darwin, Charles Darwin's son and past president of the Eugenics Society of England, 'Eugenics is the study of heredity as it may be applied to the betterment, mental and physical, of the human race'.[18] While people disagree about precisely which traits are worth promoting, what motivates eugenics is a concern that individual welfare depends in part on the average traits of a population, and that demographic trends matter to the extent that they influence the success or failure of entire populations.

Apart from demographics *within* countries, there is a massive divergence in fertility trends *across* countries – one that has never been seen before on the planet. The rise in wealth and education in Europe and Asia has produced falling fertility. But global population is still rising. Financial aid from Europe and North America to Africa, mostly in the form of

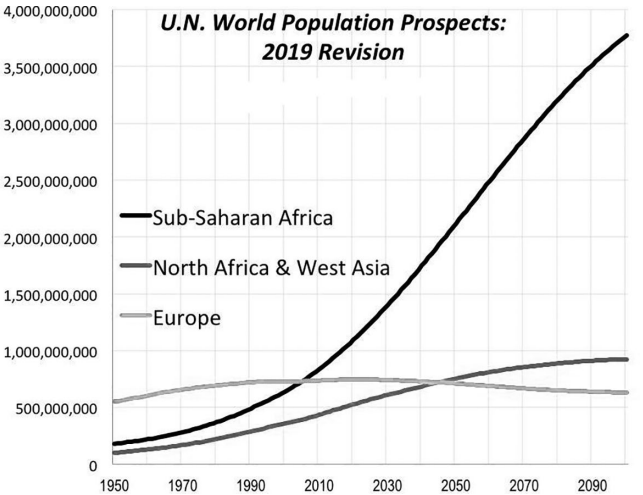


Figure 5.1 UN World Population Prospects: 2020 Revision

food and medicine and other technologies, along with the discovery of oil in North Africa and the Middle East, has contributed to an unprecedented population boom in the poorest countries around the world (see Figure 5.1).

Meanwhile, many environmentalists and journalists in Western countries have called on people in countries with already low fertility rates to have fewer children. The argument is that any additional child added to a world with scarce resources is likely to contribute to global pollution, climate change, deforestation, and other environmental threats.

But the argument leaves out the global *benefits* of population growth in countries with stable political institutions. If the argument to have fewer kids is most likely to be heeded by educated and compassionate people in developed countries, it will produce the opposite of its intended effect by suppressing scientific inventions that would otherwise be developed, and increasing the speed with which fertility falls in these countries.

WHY HAVE CHILDREN?

Historically people have had kids for a variety of reasons: because sex is fun, and kids came along as a byproduct; because our religion or community enjoined us to 'be fruitful and multiply'; because we needed children to help work the land and take care of us in old age; and because, in more recent times, many people find having kids to be part of a fulfilling life.

Some have argued that, on balance, most human lives involve more suffering and harm than benefit, so we should stop reproducing altogether.[19] Even if this were true, it can presumably be changed through deliberate genetic modification, thus tilting the calculus so that life is a net benefit.

Assuming life is – or could become – a net benefit, we might increasingly encounter a reproductive collective action problem. We have seen that many wealthy, educated people have below replacement fertility: that is, they have too few children to keep the population stable. They do this in part because higher income and more education allow them to enjoy opportunities that are unavailable to poor people. If we assume future people would benefit from smart, compassionate, educated people having more children now, it looks like we have an inter-generational free rider problem: if life is valuable, and future life has the potential to be better than it is now, we may have a moral *obligation* to have children.[20]

Morality evolved, in part, to solve local collective action problems like hunting together, waging war, and keeping the local environment clean to prevent infectious disease.[21] Our moral emotions and social norms are, in effect, devices that help us override our tendency to think in purely selfish terms. But these emotions and norms are not especially good at solving global, inter-generational collective action problems

because the benefits are too distant for most people to recognize the consequences of their actions, or to care much about them. This presents special problems when confronted with global pollution, species extinction, and reproductive patterns that determine who is born, and how well-off they are likely to be.

While it is rarely discussed in polite company, having children may be the most important moral obligation we have, provided we are likely to rear happy and healthy children. There is a reluctance to acknowledge this obligation, I think, because having children is intensely personal, and it radically alters the direction of our lives. It can even make us less happy in the first few years of our children's lives, since we lose sleep and women in particular undergo physical alterations that are difficult to endure. Overall, though, having children can be part of a good life, and it may make us happier if it encourages us to engage with our community more, gives us a sense of meaning outside of ourselves, and connects us to the past and the future in a deeper way.

Perhaps the reason an obligation to reproduce is not widely acknowledged is that some people can't have children (though this will change with surrogates, induced pluripotent stem cells, etc.). We should not shame people for failing to do something they cannot do. As moral philosophers say, *ought* implies *can*, so if I cannot have healthy children, there is certainly no obligation for me to reproduce. But saying most people have a moral obligation, or a moral reason, to reproduce does not commit us to saying that *everyone* does, or that our moral obligations should be backed with coercive laws that force us to reproduce.

Apart from the value future children will create and experience, especially if they are conceived in ways that enhance

their capacities, why should we care if life goes on into the future? Does anything matter in the end?

I don't think it does. In about a billion years, the sun will expand to such an extent that it will make life on earth impossible. If we escape to other planets (in some form or other), those too will eventually roast, and become engulfed by dying stars. Eventually the energy in the universe required for life will dissipate to the point where life will become impossible. All of our efforts and inventions will be destroyed without any trace.

While all of this is true, I cannot shake the conviction that life is (usually) worth living, and that we should continue to create the conditions for intelligent life to experience beauty, create art, discover how the world works, and continue to set and satisfy goals that presuppose a complex form of intelligence. It is at this point that our intuitions bottom out. If you think that life is pointless, given that we will leave no trace in 20 billion years, it is hard to know how to convince you to believe otherwise. An obligation to reproduce, no matter how weak it is, cannot exist unless there is value to the future experiences intelligent creatures will have.

SHOULD WE STAY A SINGLE SPECIES?

Toward the end of the first chapter I discussed whether if some people genetically enhance their children and others don't future people might eventually end up with unequal moral standing. I concluded that even if there are thresholds rather than gradual slopes that determine our moral standing, inequality could become significant enough to give different groups of people different moral standing. While it is true that, as we are now, people count more than clams, it is also true that just being a bit brighter or more empathetic

doesn't make one person morally better than another. People who meet a basic threshold are entitled to a certain amount of autonomy, respect, and so on.

But with enough assortative mating,[22] or with the repeated use of genetic enhancement technologies across generations, we are likely to either become a separate species from those who decline to enhance, or at least have such large differences in ability that we cannot live together productively. We would want very different things, and enhanced people may regard unenhanced people with pity or contempt. Perhaps the enhanced wouldn't think of the unenhanced much at all, in the same way we currently don't think much about the inner lives of squirrels or cats.

Is this a moral problem? Might it give us reasons to reject enhancement, and maybe even ban it? I don't think so.

First, it is wrong to prevent some people from having more simply because others don't have as much. Some people are inclined to take a snapshot of the world and infer from this inequality of outcome some form of unfairness.[23] They falsely believe that for someone to have more, someone else must have less. Economists even have a name for this mental mistake: the zero-sum fallacy, which reflects the widely shared but misguided belief that inequalities require gainers and losers. In reality, if you're a good doctor, you may earn more than most of your patients, but your patients are better off for your presence than they would be without it. Similarly, genetically enhanced people are likely to create innovations that the unenhanced cannot create. And morally enhanced people may, in principle, make the world a safer and nicer place to live in by stabilizing political institutions and promoting prosocial norms that benefit everyone, including the unenhanced.

Second, legal prohibitions on enhancement that are intended to prevent genetic stratification would be difficult to enforce, and may produce moral consequences that are worse than the inequalities they are intended to prevent. Some people call for blanket bans on genetic engineering and cloning. I've already discussed why I think this is neither desirable nor feasible, mainly because of medical tourism and black markets. Even among scholars who recognize that unilateral bans among nations are unlikely to work, some call for global treaties to ban genetic engineering technologies.[24] But the costs associated with enforcing a global ban on genetic enhancement would be enormous. In fact, it would plausibly require absolute political power, with a police state to ensure nobody violates the prohibitions. Even then, there are no guarantees.

Why would the police themselves, or the politicians who order them to arrest sellers and buyers of genetic technologies, comply with the laws? Just as drug and alcohol prohibition often ends up with the authorities using and selling the drugs and alcohol they're tasked with regulating, technologies like embryo editing will be too powerful to pass up for those who are tasked with enforcing laws, and those whose choices the laws are supposed to curtail.

Bans on genetic enhancement will be especially difficult to enforce in low-trust societies with high levels of corruption. Many modern states are large, multi-ethnic, and multicultural. Such societies have economies of scale, which allows them to afford a large military and basic infrastructure. But they are also a recipe for lower trust, more division, and incentives for citizens to form coalitions in order to seize resources from other citizens, rather than working in harmony toward common goals. In cases like this, citizens who push for prohibitions on enhancement, against the will of a sizeable portion

of their population, may ultimately create the conditions in which those closest to political power can access resources that others cannot.

Instead of moral and legal prohibitions to prevent inequalities, it is more plausible to suppose different kinds of people will wish to separate into different political communities. They would do this, for example, if government welfare programs socialize the benefits and costs of productive work, or if unenhanced people would – in various ways – seriously undermine the welfare of enhanced people. Separation need not be violent or involve animosity. It could reflect the reality that groups have become so different that, even if they can still interbreed, they cannot live together productively. Living apart may be safer for all than forcing very different kinds of people into a single political community. If, as John Rawls says, a political community is a cooperative venture for mutual advantage, and there can be little or no reciprocity between very different kinds of people, there is no point in sharing political institutions.[25]

This would require rethinking the moral foundations of the large nation states in which many of us now live. One cost of allowing smaller, more decentralized political communities is that they tend to be stable only when there are high entry and exit costs, and less privacy than we expect in large cities like New York or London. But this may be a cost worth paying in order to prevent unnecessary animosity or violence between groups with very different capacities to cooperate on mutually beneficial terms.

NOTES

1 Hutchison, 'Design and Synthesis of a Minimal Bacterial Genome'.

2 Archibald, *Genomics*, p. 51.

3 Enriquez and Gullans, Evolving Ourselves: Redesigning the Future of Humanity – One Gene at a Time.
4 Buchanan *et al.*, *From Chance to Choice*, p. 210.
5 Dillard, 'Rethinking the Procreative Right'.
6 Shiffrin, 'Wrongful Life, Procreative Responsibility, and the Significance of Harm'.
7 Zigerell, 'Understanding Public Support for Eugenic Policies.'
8 Benatar, 'The Limits of Reproductive Freedom', p. 79.
9 Kanazawa (2014) argues that although intelligence and income are positively correlated, intelligence itself is only negatively correlated with fertility for women, not men. This may have something to do with women, on average, having a stronger preference than men for mates with equal or superior education or social status.
10 Darwin, *The Descent of Man*, Part 1, Chapter 5.
11 Schrödinger, *What is Life?*, p. 105.
12 Muller, 'Our Load of Mutations'.
13 Powell, 'In Genes We Trust'.
14 Chesterton, *Orthodoxy*, p. 15.
15 Darwin, *Descent of Man*, Part 1, Chapter 5.
16 Anomaly, 'Defending Eugenics'; Cavaliere, 'Looking into the Shadow: The Eugenics Argument in Debates Surrounding Reproductive Technology'.
17 Veit *et al.*, 'Can Eugenics be Defended?'. We can use words however we like, provided we define them clearly. But the move to stigmatize the word 'eugenics' strikes me as pointless. I prefer instead to identify what was wrong with some eugenics programs, and what might be right with others, especially since 'eugenics' is increasingly as a term of abuse rather than a word people engage with in a neutral way (Anomaly, 2022).
18 The quote is from a pamphlet printed by the Eugenics Education Society in 1923. It can be found in the Wellcome Trust Archives: https://wellcomecollection.org/works/e5pss78j
19 Benatar, *Better Never to Have Been*.

20 Smilansky, 'Is there a Moral Obligation to have Children?'
21 Bowles and Gintis, 'The Evolutionary Basis of Collective Action'.
22 Assortative mating occurs when mates seek traits similar to their own, and the result is offspring with a higher chance of having a concentration of those traits. For example, there is strong assortative mating among humans for qualities like height, intelligence, and political orientation.
23 Nozick, *Anarchy, State, and Utopia*.
24 Annas *et al.*, 'Protecting the Endangered Human'.
25 Rawls, *A Theory of Justice*.

Conclusion

Most people don't think about how genetics will reshape our world over the next century. Even among those who understand the science of embryo selection and gene editing, many are currently skeptical of using it. Some of this reflects a legitimate concern that we don't yet know enough to alter complex traits. But some of it is an unjustifiable bias in favor of the status quo. An analogy can be made with genetically modified food. Some people have expressed legitimate worries about the consequences of genetically modified food for the environment (for example, an increased risk of blight among crops that are too genetically similar). Others wonder whether we know enough about nutrition to ensure that genetically modified foods have all of the nutrients we would get from 'natural' crops.

But a lot of fear comes simply from using new technologies. So far the science is pretty clear: genetically modified food is just as nutritious and in many cases cheaper and healthier than traditional crops, and it is better for the environment than traditional crops, even if we do need to guard against monocultures.[1] It can also help us avoid the need to spray crops with pesticides, since we can build disease resistance into genetically modified plants. Popular opposition to genetic modification is beginning to fade as consumption of modified food becomes more widespread. It is likely, I think,

DOI: 10.4324/9781003464266-6

that a similar pattern will emerge for genetically enhanced embryos.

At first, a few wealthy technophiles are likely to use polygenic risk scores to increase their children's intelligence or select for aesthetic traits like height and eye color. At the same time, some religious leaders may object to reproductive technologies like IVF and IVG on the grounds that parents will create embryos and then destroy most of them. Other objections will emerge from political egalitarians in places like the USA, where an ideology that emerged after WW2 led elites in the media and universities to deny that genes play a crucial role in socially valued traits like intelligence.

Because the dominant view among American elites in the early 2000s is that only oppression or discrimination – not genetics – can explain social disparities between individuals and groups,[2] many journalists and professors will initially condemn the technology. This is because they will understand that if polygenic risk scores can predict important life outcomes, this fact will conflict with their worldview. Because this implication is so obvious, and because ideology is hard to shake, many elites will engage in moral grandstanding – they will condemn the technology in order to publicly declare their fealty to the dominant political ideology. But as the technology improves, it will also lead to cognitive dissonance among elites who wish to use embryo selection to give advantages to their children, but who are also ideologically committed to opposing it. Eventually, more elites will openly use the technology, and a preference cascade will cause more people to move from reluctance and condemnation to support for embryo selection, and eventually gene editing.

Norms and technology will co-evolve, as the cost of opting out of using genetic technology grows. At that point, at least

within some societies, there may be social pressure to avoid 'old fashioned' births, and carefully screen children for traits that predict healthy, happy lives. Indeed, there are early signs that social taboos against genetic selection are weakening. In 2023, a group of scholars published a survey of American attitudes toward embryo selection.[3] The survey gauged three things: parental attitudes toward using tutoring to boost their child's chance of gaining admission to an elite university, and their attitude toward using embryo selection or gene editing to accomplish the same goal. Nearly half of Americans said they consider embryo selection for intelligence *morally* justifiable, as well as something they would *personally* consider using. Only a slightly lower percent said they would use gene editing to accomplish the same end, assuming it was safe. More importantly, younger people of reproductive age were more favorable than older people toward genetically enhancing their children. This suggests that attitudes are changing, and that while elite opinion often shapes ordinary people's attitudes, taboos against genetic enhancement are likely to fade once the cost plummets and the technology matures.

Others may continue to reject enhancement. After many years divergence would occur. If the costs of opting out of genetic enhancement are felt by those who opt in, and become very high, political separation is likely to result, and may be morally preferable to forcing others to enhance their children, or eliminating them. However, if the unenhanced pose a threat to the enhanced, perhaps because they have access to technologies created by the enhanced, but lack the foresight, patience, or moral constitution to interact on peaceful terms, they might be coerced to either enhance their children or be prevented from having children at all.

We are the product of evolution by natural selection. The environment has changed us by culling those of our ancestors who were poorly adapted to past conditions. And we have changed the environment in ways that make it more likely that people with particular traits will have more children than others. There has never been an *essential* or pan-human nature that is stable over long periods of time.[4] In this sense, genetic modification isn't new, even if the tools are. What is new is the ability to make *conscious* choices about the traits of our descendants.

Evolution is path-dependent. Future populations will be shaped by the choices parents make now. These choices will be influenced by the social and political institutions they live under. It is up to us to think through what kinds of institutions we should create, and what kinds of future people should exist.

NOTES

1 Pellegrino *et al.*, 'Impact of Genetically Engineered Maize on Agronomic, Environmental and Toxicological Traits: A Meta-analysis of 21 Years of Field Data'.
2 Anomaly and Winegard, 'The Egalitarian Fallacy'.
3 Meyer *et al.*, 'Public Views on Polygenic Screening of Embryos'.
4 Weingard *et al.*, 'Dodging Darwin: Race, Evolution, and the Hereditarian Hypothesis'.

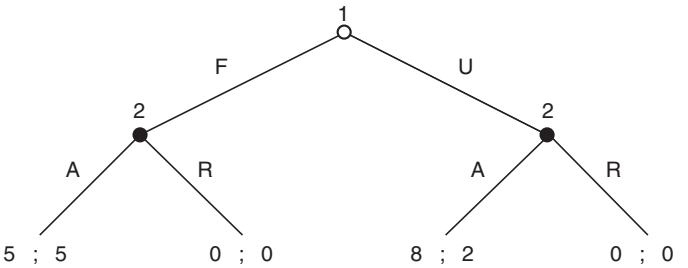
Appendix A

The Ultimatum Game is a way of eliciting preferences over fair distributions of resources. In the simplest version, an experimenter designates two people, *Proposer* and *Responder*. The experimenter explains that he will give the two people ten dollars to split, provided both accept the split that the Proposer decides on. If the Responder accepts the split, they receive the money. If the Responder rejects the split, neither gets anything.

If he were purely selfish, Responder would accept any offer above zero. For example, if Proposer offered to keep $8 for himself and give $2 to Responder, R should be happy that he is richer after the offer than he was before the experiment. However, many Responders reject low offers, which leaves themselves worse off. This may be called 'altruistic punishment' when rejecting an offer makes the individual worse off, but satisfies his sense of justice.

The game typically does not say where the money comes from, so the sense of desert we often associate with earned money doesn't come into play. This is one way in which the Ultimatum Game fails to capture the richness of intuitions we have about fair distributions of resources.

In the following diagram, F = Fair, U = Unfair, A = Accept, R = Reject, and the numbers represent possible offers made by Player 1 to Player 2.



Appendix B

Suppose you and I are arrested for robbing a bank and interrogated separately. The ambitious District Attorney wants at least one prosecution (to show that he's a tough DA), and so offers each of us the following deal:

> You have a choice – snitch on your accomplice or stay silent. If you snitch and your accomplice doesn't, I will drop all charges against you and use your testimony to ensure that your accomplice serves a life sentence. Likewise, if he snitches on you and you stay silent, he will go free while you do the time. If you both snitch I get two convictions, but I'll see to it that you both get early parole after a 5 year sentence. If you both stay silent, I'll have to settle for token sentences on firearms possession charges, and each of you will get a 5 month sentence.

In the following diagram, outcomes on the left side of each box are mine; outcomes on the right are yours.

		YOU	
		Silence	*Snitch*
ME	Silence	2nd, 2nd	4th, 1st
	Snitch	1st, 4th	3rd, 3rd

1st best = go free; 2nd best = 5 months; 3rd best = 5 years; 4th best = life sentence

		YOU	
		Silence	*Snitch*
ME	Silence	Each gets 5 months	I get life, you go free
	Snitch	I go free, you get life	Each gets 5 years

Each of us is best off snitching since, for each, this will yield either our 1st or 3rd best outcome, rather than our 2nd or 4th best. Each thinks: no matter what you do, I'm better off snitching – if you stay silent and I snitch, I go free (rather than getting 5 months); if you snitch and I snitch, I get 5 years (rather than a life sentence). In the Prisoner's Dilemma, snitching is the **Nash equilibrium**, which is defined as any position in the payoff matrix from which neither player can unilaterally improve his outcome. Snitching is also the **dominant strategy**, which means that it provides the best possible payoff regardless of the other player's action.

The Public Goods Game

Appendix C

In a classic Public Goods game, an experimenter allocates money to a small group of players. Let's say each player gets $10. Each player is invited to invest some or all of the $10. Players are told that however much money is invested will be pooled together, doubled, and then reallocated to all members of the group.

If each player invests all $10, each gets $20 back. But if the investment is anonymous, some might be tempted to free ride by keeping most or all of their $10 endowment, and hoping others invest, so that he can take a fraction of their investment. Other players, being more generous or trusting, might fear such free riders and invest less than they otherwise would in order to avoid being exploited.

In typical low-stakes Public Goods games like this, the mean investment is about half – though some invest all of their endowment and others none. While the reasons people give are diverse, a typical response to the question of why they gave a certain amount is that it seemed fair.

Public Goods games can be single play or repeated. When repeated, contributions tend to decline unless opportunities to punish free riders (players who invest little or nothing) are introduced. When punishment is available, it tends to get used, even at a personal cost to the punisher. The net result of introducing 'altruistic punishment' is that investments tend to increase in subsequent rounds.

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Glossary

PHILOSOPHY

eugenics The belief that we should use the science of genetics to try to improve the welfare of our children. The word was coined by Galton from the Greek roots *eu* + *gen* (*good* + *birth*).

genetic enhancement Any genetic intervention that is expected to increase the chances of a person leading a good life. On this definition, calling something an enhancement does not commit us to saying it would be good, all things considered (the kinds of collective action problems discussed in the first four chapters illustrate why).

pathological altruism Situations in which the attempt to promote others' welfare produces harmful rather than beneficial effects.

procreative altruism The moral principle that parents should try to create children whose existence can be expected to contribute more to the well-being of others than any alternative child they could have.

procreative beneficence The moral principle that parents should try to create children with the best chance of the best life, given the available information.

behavior genetics The study of how genes interact with the environment to influence behavior.

CRISPR Short for Clustered Regularly Interspaced Short Palindromic Repeats. CRISPR allows bacteria to sequence and disable viruses that attack them. Because of its accuracy, scientists use a version of this system (usually CRISPR Cas9) to make precise cuts to DNA in order to alter genes, including the genes of human embryos.

gene editing Altering specific variants of DNA in order to achieve a phenotypic effect. CRISPR is currently the most powerful and accurate tool for editing genes.

heritability A metric behavior geneticists use to measure how much genes explain the *differences* between individuals within a given population.

in vitro fertilization (IVF) A procedure that involves combining a sperm and egg outside of the body before implanting it inside the body to induce pregnancy.

in vitro gametogenesis (IVG) The process of converting an adult cell, such as a blood or skin cell, into a pluripotent stem cell, which can then be used to create sperm or egg cells.

pluripotent stem cell A cell capable of becoming any kind of specific cell, such as a blood, skin, bone, or sperm cell. *Induced* pluripotent stem cells are derived by taking an adult cell and turning it into a pluripotent stem cell.

polygenic risk score A way of gauging the likelihood that an embryo will develop a trait, given that the trait involves many different genes interacting with one another.

pre-implantation genetic testing (PGT) A procedure that allows us to scan the genome of an embryo before it is implanted in order to test its likelihood of developing

specific traits (the technical word for a pre-implantation embryo that hasn't yet divided is 'zygote', but most people use 'embryo' informally to cover zygotes as well).

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collective action problem A situation in which each person acting rationally, according to their own goals, produces a worse outcome than they would if most or all people affected by the situation acted in a different way.

externality A cost or benefit borne by someone *external* to a transaction.

game A situation in which the outcome for the relevant players is a function of the choices of each player. Poker is an example: winning a game depends not just on my cards, but also on the cards everyone else has.

game theory The study of games, including the strategies most likely to work for a particular player, and the outcomes most likely to be stable. For example, nuclear deterrence can achieve peace when each party *believes* the other party will retaliate to a first strike, whether or not they really intend to retaliate to a first strike.

Nash equilibrium A stable position in a game. For example, in a simple coordination game, everyone driving on the right side of the road, or everyone on the left, is a Nash equilibrium.

network effect The effect that an additional user of a product has on others who use it. Network effects can be positive or negative, but typical examples of network effects are positive feedback loops that occur when more people using a good or performing an action make others better off.

public good A good, or an outcome, that is freely available to all once it is produced. *Public* goods are contrasted with *private* goods that allow individual owners to exclude others from consuming a product they create or own.

STRATEGIES IN A REPEATED PRISONER'S DILEMMA GAME

always cooperate Cooperate with other players no matter what they do.

always defect Defect against other players no matter what they do.

conditionally cooperate Cooperate if and only if your opponent cooperates.

strong reciprocity A disposition to cooperate first, and to steadily increase cooperation in response to another player's willingness to cooperate, but also to punish defectors, even at significant personal cost to the punisher.

weak reciprocity A disposition to conditionally cooperate.

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