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Germ-Line Enhancement of Humans and Nonhumans

ABSTRACT. The current difference in attitude toward germ-line enhancement in humans and nonhumans is unjustified. Society should be more cautious in modifying the genes of nonhumans and more bold in thinking about modifying our own genome. I identify four classes of arguments pertaining to germ-line enhancement: safety arguments, justice arguments, trust arguments, and naturalness arguments. The first three types are compelling, but do not distinguish between human and nonhuman cases. The final class of argument would justify a distinction between human and nonhuman germ-line enhancement; however, this type of argument fails and, therefore, the discrepancy in attitude toward human and nonhuman germ-line enhancement is unjustified.

People have widely disparate attitudes toward human and nonhuman genetic engineering. This discrepancy is clearest in North America. Most varieties of genetic intervention in humans receive attention in the popular press, are thoroughly analyzed by professional ethicists, and are approached by scientists with a great deal of caution. Meanwhile all kinds of genetic intervention in nonhumans, including genetic engineering, is proceeding on an industrial scale in North America with spotty notice in the popular press, little criticism from professional ethicists, and arguably little regulation by the government. Admittedly, many environmental groups have launched campaigns against genetically modified organisms (GMOs), but they have not captured the attention of the mainstream public. The situation is different in Europe, but even there one finds a discrepancy in attitude toward human and nonhuman genetic modification. Although there is opposition to the genetic engineering of nonhumans, the genetic engineering of humans is looked upon with genuine dread.

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I argue that a serious examination of the risks and benefits of genetic technologies will show that this gap in attitude is unjustified. We should exercise far more caution in altering the genes of nonhumans, and be more bold in altering the genes of humans. I begin by outlining in more specific terms what technologies are in question, what moral distinctions are made, and what the prevailing attitudes are. I then divide the arguments typically brought against genetic engineering in humans and nonhumans into four classes: safety arguments, justice arguments, trust arguments, and naturalness arguments. I show that the first three classes of arguments are moderately effective. These cogent arguments signal a need for great caution and apply equally to humans and nonhumans. In the case of nonhuman genetic engineering, they signal a need for more caution than is currently being exercised in North America. Things are different when it comes to the "naturalness arguments." These arguments, I believe, lie behind the difference in our treatment of human and nonhuman genetic engineering. People, especially Americans, feel the pull of naturalness arguments more strongly when it comes to humans. Moreover, this kind of argument generally leads to outright prohibition, rather than close regulation. The problem is that naturalness arguments all fail. No members of the class are cogent. I conclude that our policies towards genetic engineering need to be reshaped.

LAY OF THE LAND

By genetic engineering I mean any member of a family of protocols that includes the following techniques: direct or vector-mediated insertion of DNA, gene surgery, or mutagenesis. This definition is meant to capture the sorts of genetic alterations that are more efficient at altering a species and more targeted to altering specific genes than ordinary selective breeding.

The form of genetic engineering on which I focus is *germ-line enhancement*. A form of genetic engineering is called "germ-line" if it affects the sex cells and thus can be passed on to future generations. Otherwise it is called "somatic cell" engineering. A form of genetic engineering is called "enhancement" if it alters a trait that is within the norm for the organism and changes it to a superior position within the normal range of variation or moves it beyond the norm altogether. The remarkable thing about germline enhancement is that it is the most ethically suspect of all the categories of genetic engineering in humans, yet it is the *preeminent* kind of genetic engineering practiced on nonhumans. Regulators in the U.K., fol-

lowing the recommendations of the Committee on the Ethics of Gene Therapy (1992), simply forbid both human germ-line engineering and human enhancement engineering (GTAC 2002). The Council of Europe in 1999 declared that human germ-line and enhancement engineering were offenses to human dignity and banned them in all signatory countries (COE 1999). Although its findings do not have the status of law, a government bioethics board in Canada reached the same conclusion (Royal Commission on New Reproductive Technologies 1993, pp. 931, 938, 345). In the U.S., a commission funded by the American Association for the Advancement of Science reluctantly concluded that circumstances may exist in which human germ-line engineering would be acceptable, but the group was adamant that it be restricted to treatment, not enhancement (Frankel and Chapman 2000, p. 42). Similarly, the Human Genome Project had a ban on all human germ-line engineering projects (McGee 2000, p. 30). Standard undergraduate bioethics textbooks inform students that germ-line engineering is more problematic than somatic cell engineering and that engineering aimed at enhancement is more problematic than that aimed at treatment (Munson 2000, p. 591; Mappes and DeGrazia 2001, p. 515). Although the germ-line enhancement of humans is regarded with profound dread, it is essentially the only form of genetic engineering being performed on nonhumans. No one would bother genetically engineering an agricultural animal or plant if the alteration must be repeated every generation, and no one would use such an expensive technique to restore to health an organism that simply can be destroyed and replaced.

My chief example of germ-line enhancement in nonhumans is the use of herbicide-resistant plants in agriculture, such as the Roundup Ready line or BXN cotton. Generally the same company that sells the GM seeds also makes the herbicide, and the two are sold as a package. The farmer can thus blanket her crops with the herbicide, knowing that it is likely to affect only the weeds. This is by far the most common GMO, accounting for 83 percent of GM crops worldwide (James 2002). Although many benefits have been cited for herbicide-resistant crops, their only direct benefit is to increase yields relative to cost. They do this by allowing the farmer to kill more weeds with fewer applications of herbicide.

With respect to humans, I focus on two germ-line enhancements that affect the body: the retardation of natural aging and the general improvement of the immune system. It is not difficult to imagine a germ-line enhancement that slows or arrests natural aging, for instance by improving the body's ability to break down free radicals, or somehow altering cell

senescence (see Walters and Palmer 1997, p. 103; Rose 2000). Similarly, one easily can imagine the possibility of altering the immune system so that it is better overall at identifying and eradicating foreign agents. As LeRoy Walters and Julie Palmer (1997, p. 110) point out, we already do this in a nongenetic way when we immunize our children against diseases. (We do not like to think of immunization in children as a form of enhancement, because it fits the typical medical goal of fighting disease. It nevertheless is an enhancement, because it raises human functioning above the species-typical level.)

I would be happy to see either of these alterations become commonplace in humans. Life expectancy at birth already has tripled since the Upper Paleolithic (Diamond 1987), and I welcome the next tripling. I am quite worried, however, about the use of herbicide resistant crops, which I think will make a bad global food market worse. To see how I arrive at such an inverted worldview, we need to examine the arguments typically raised around germ-line enhancement.

SAFETY ARGUMENTS

Real safety concerns exist for the use of all the technologies I am discussing; these concerns are equally strong for both human and nonhuman germ-line enhancement, and they indicate a need for close regulation, rather than a ban. In the case of nonhuman germ-line enhancement, the safety risks indicate a need for more caution than is currently being exercised in North America.

There are three main categories of risk in nonhuman germ-line enhancement: concerns about the safety of consumers, concerns about the safety of the environment, and concerns about the welfare or rights of transgenic animals. It is important to note, however, that there are also potential benefits in all these categories. Foods can be altered to be healthier. Gary Comstock (2000) points out that one widely consumed GMO, bt corn, actually may be more healthy than traditionally bred corn because it is less likely to grow mold during shipping. Use of transgenic crops also can benefit the environment by reducing the amount of pesticides sprayed on fields and reducing the acreage needed to farm. Finally, farm animals can be altered in ways that improve their standard of living. Bernard Rollin (1995, p. 170) points out that all cattle could be engineered with the poll gene, which currently is found only in some species, and which keeps them from growing horns. This would obviate the need for painful and bloody dehorning procedures, which are generally done without anesthesia.[1]

Nevertheless, the array of situations in which safety concerns arise is gigantic. Space considerations prevent me from offering an opinion on every release of transgenic organisms. Instead I will argue by example. I claim that the U.S. Animal and Plant Health Inspection Service (APHIS) should not have granted nonregulated status to Roundup Ready soy. Roundup Ready soy poses real risks and, more importantly, offers virtually no benefits.

Since 1996, APHIS has been the point agency for the environmental regulation of GMOs. APHIS bases its jurisdiction on the fact that most GMOs contain genes from an organism already listed as a plant pest, typically a promoter sequence from the cauliflower mosaic virus or genes from *Agrobacterium tumefaciens*, which is used as a vector and a source of stop sequences (APHIS 1987). Anyone who wishes to market a GMO in the U.S. at least must notify APHIS of the intention to do so. At this point, the seed company generally asks APHIS to grant the product nonregulated status, which absolves it from all future oversight. This includes all postcommercialization monitoring, which means that no effort is made to follow the crop once it is introduced to the environment to see if it is as safe as regulators thought.

In 1993, Monsanto requested that its Roundup Ready soybean be granted nonregulated status (APHIS 1994a, 1994b, 1994c). The plant is designed to resist glyphosate, the active ingredient in Monsanto's Roundup herbicide. Glyphosate is a good herbicide, as herbicides go. It breaks down quickly in the environment and does not bioaccumulate as it goes up the food chain the way DDT does. The primary effect of glyphosate is on photosynthesis, which obviously does not impact animals. However, experiments with rats "suggest a mild toxicity" to the liver system (Chan and Mahler 1992). More importantly, Roundup contains the surfactant polyoxyethyleneamine (POEA) to make it spread more evenly. POEA has been linked to the deaths of 20 people who ingested herbicides directly (Sawanda et al. 1988; Tominack et al. 1991).

APHIS granted Roundup Ready soy nonregulated status based on information from nine field trials reported by Monsanto and 33 letters of public comment solicited by APHIS in the *Federal Register*. APHIS determined that Roundup Ready soy was not a plant pest and therefore did not fall under their jurisdiction and would not be subject to any further regulation.

Roundup Ready soy poses many environmental risks that were considered inadequately or not at all by APHIS. Many risks involve high amounts of scientific uncertainty and are compounded by the fact that there is no mechanism for monitoring the effects of a GM crop after it is on the

market. One class of risks APHIS did not consider at all comes from the long-term increased use of glyphosate, including the unprecedented aerial spraying of glyphosate (Lappé and Bailey 1998, p. 40). Glyphosate is known to disrupt the soil's microflora, killing some organisms and causing others to proliferate wildly. What long-term use of it means for the microbial environment is not known (Lappé and Bailey 1998, p. 80). Glyphosate also can enter the human food supply, largely through the use of soy products in animal feed (Lappé and Bailey 1998, p. 80). A second category of risks not considered at all involved the pleiotropic and position effects of gene insertion. It is well known that genes have multiple effects (pleiotropy) and that these effects are determined by the position in the genome (position effects). There is no way to know what else the Roundup Ready construct did to the soybean besides confer Roundup resistance, again entailing unknown risks.

APHIS did consider the possibility that Roundup Ready soy might interbreed with its wild and weedy relatives, *Glycine soya* and *Glycine gracilis* (APHIS 1994b, p. 6). Because *G. soya* and *G. gracilis* only grow wild in Asia, the risk in question comes from the spread of Roundup Ready soy outside U.S. borders. APHIS, however, is required by law to consider the impact of deregulation in the U.S. on the spread of a GMO elsewhere. APHIS's efforts to fulfill this mandate were token, at best. In their environmental impact statements, APHIS (1994b) simply pointed to the existence of international and Asian regulatory agencies and asserted that they would be adequate to the task of preventing the spread of Roundup Ready soy to areas where gene pollution is a threat. However, many Asian nations have shown a willingness to flout international intellectual property agreements, and it is entirely possible that trade in pirated seeds will become as common as trade in pirated CDs.

Scientific unknowns obviously play a large role in many of these issues, which makes the lack of postcommercialization monitoring troubling. For instance, we could learn something about where the Roundup Ready gene construct landed by watching how the crops behave over many generations on a large scale. We are not doing this. We could discover something about the spread of transgenes to related organisms all over the globe if we were looking for those transgenes. We are not doing this either. The National Research Council (NRC 2002) has recommended a system of postcommercialization monitoring for GMOs, and it is hard to disagree with their suggestions. Unless we examine the outcome of our actions, we risk repeating mistakes indefinitely.

Of course, any cost-benefit analysis must include a discussion of benefits. What, then, does Roundup Ready soy offer the world? Roundup Ready soy was designed to increase production relative to costs. Now, although some farmers may try to use the decreased costs to increase their profit margins, competition quickly will force them to drop prices. This effect is pernicious in a market where prices are already depressed due to overproduction. Worldwide per capita soy production has increased 93.8 percent in the last 50 years (FAO 2003). Anyone with a little high school economics realizes that this means the price of soy should be down, and indeed it is: the price of soy has been cut roughly in half since 1970 (World Bank 2000). Frederick Kerschenmann (2003) and others point out that although it is rational for an individual farmer to plant Roundup Ready soy, because she will gain an advantage over her neighbors, it is not rational for farmers collectively adopt its use. Once everyone is using the Roundup Ready system, the only way to support farmers income will be to increase federal subsidies, again.

One might protest that the benefit of decreased production costs was not meant to benefit farmers, but rather consumers, either in the First World or the Third World. I will set aside the issue of the Third World food supply until the section on justice arguments, below. Regarding First World consumers, I need note only that there is a reason that prices for soy are depressed. Supply already far exceeds demand.

The intended effect of Roundup Ready soy is basically pernicious. Other benefits have been touted for it, however. APHIS (1994c), in granting Roundup Ready soy nonregulated status, cited two possible benefits of note: (1) by allowing farmers to use Roundup after emergence, and to use fewer applications of Roundup, Roundup Ready soy may reduce the net amount of pesticide released into the environment; (2) Roundup Ready soy may allow farmers to reduce erosion by switching to low-till or no-till agriculture. The problem with these two potential benefits is that their likelihood has not been researched thoroughly, simply because they are not the intended outcome of the genetic modification. Both of these outcomes depend not only on the product being adopted, but on other courses of action being taken by consumers, yet no market research has been done to see whether farmers will behave this way.

I conclude that we are taking at least some unjustified risks in the regulation of GM crops. Furthermore, I claim that this example is representative of much of the genetic modification that is going on today. Safety arguments indicate a need for greater caution and regulation in the use of GMOs, but not a ban.

The situation is different for human genetic engineering. Here there are obvious safety concerns. Human genetic engineering, in the form of somatic cell treatment, has killed a person (Savulescu 2001) and induced cancers in others (Kaiser 2003). These risks become more pronounced when one moves to germ-line enhancement. Attempting to extend life by tinkering with cell senescence poses an obvious cancer risk, while general immune system enhancements pose the risk of autoimmune disorders. Nevertheless, there are categories of risk that are present for nonhumans that are not present for humans, including dangers to the environment. Also, the sheer scale of the nonhuman alterations creates risks that will not be present in humans. On the whole, there is no qualitative difference to be drawn. Therefore the response should be the same: adequate regulation.

The real difference between the two loci for germ-line enhancement is the safety mechanisms that are clearly in place when it comes to human germ-line enhancement. The front line of regulation is an institution that does not even exist in the agricultural companies engaged in nonhuman genetic engineering: the institutional review board (IRB). The FDA and the Recombinant DNA Advisory Committee (RAC) at the National Institutes of Health provide additional regulation. What is most interesting about the regulation of human biotechnology is the serious weight given to the unpredictable nature of genetic alterations: "Both the RAC and the scientific community have gone to unprecedented lengths to assess and minimize both the risks of 'insertional mutagenesis' involved in the delivery and integration of exogenous DNA into the subjects cells . . . even when the risks seem quite remote" (Juengst and Walters 1999). Advocates of nonhuman GMOs, by contrast, do not even like to admit that they are in less than full control of the process.

It often is alleged that proper consent never can be obtained for human germ-line enhancement, because the person whose genes are altered does not exist at the time the decision is made to alter them and because the germ-line alteration affects all future generations (Lappé 1991; Munson and Davis 1992). Both of these problems can be overcome and, for the most part, are addressed by current regulation. The issue of the consent of the subject can be handled in the same way as other forms of experimental fetal treatment. The experiment is justified when there are good animal models, when the subject has a reasonably likelihood of benefiting from the procedure, and when proxy consent is given by the guardian. IRBs exist to ensure all these things. The problem of future genera-

tions also is not insurmountable. Again, good animal models and a reasonable likelihood of benefiting future generations are required. It would be useful as well to have some kind of proxy consent, a point that is not addressed by current regulation.

Nonhuman germ-line enhancement, on the other hand, fails to live up to reasonable ethical standards regarding consent, because GM food remains unlabeled, at least in North America. One legitimately might choose not to consume GM food out of concern for one's own health, the health of the environment, or the welfare of transgenic animals, as well as because of one's religious views —e.g., because one's religion forbids sowing fields with different kinds of seed. This option is not available as long as GM food remains unlabeled.

The conclusion I draw for both human and nonhuman germ-line enhancement is that the safety concerns are real, and the technologies require close regulation. This means dramatically reigning in current practices regarding modifications of nonhumans. The same safety concerns apply to human germ-line enhancements. Here at least the proper regulatory institutions are in place. Whether they are up to the task has yet to be seen.

JUSTICE ARGUMENTS

The concept of justice appears in different forms in nonhuman and human germ-line enhancement. The most prominent justice arguments in nonhuman genetic engineering are essentially applications of the difference principle: that special duties are owed to the world's worst off. Advocates of genetic engineering in agriculture, including the George W. Bush administration, frequently claim that it will benefit the Third World poor (Becker 2003; Sanger 2003). Certainly there are a variety of individual projects that clearly would benefit the world's worst off, such as the use of transgenic insects to wipe out insect-borne diseases. But these projects are atypical. As with the safety arguments, one needs to look at the example of herbicide-resistant crops, which are far more representative. Advocates of genetic engineering in agriculture consider the current efforts to increase production to be an extension of Norman Bourlag's "Green Revolution" (Pence 2002, p. 159) that is said to have saved 100 million lives by introducing high-yield crops to Third World countries. For the sake of argument, assume that the Green Revolution was all it is cracked up to be. Will the genetic revolution do the same? There are two questions here: (1) Will GM crops boost production relative to costs for poor farmers in the developing world? (2) Will a boost in production

relative to cost for wealthy farmers benefit people in the developing world? The answers are "no" and "no."

The most straightforward reason transgenic crops will not improve production in the developing world is that they are not being marketed there. In 2002, four countries accounted for 99 percent of the GM crops grown by acreage: the U.S. (66%), Argentina (23%), Canada (6%), and China (4%) (James 2002). Both critics and supporters of agricultural biotechnology agree that this stems in part from the lack of interest biotech companies have in other markets. They are interested in wealthy farmers "with an ability to pay for the extensive infrastructure needed to support transgenic crops" (Lappé and Bailey 1998, p. 88; see also, Paarlberg 2001, p. 3). There have been some moves recently to market GMOs in the Third World, as nations like China join the GMO club (Barboza 2003). However, these GMOs are marketed to the wealthy large-scale farmers in these countries who function essentially like First World farmers. Furthermore, the major trade initiatives have involved the export of GM food from the U.S., not the export of seed.

So, if common forms of biotechnology will not boost productivity for poor farmers, will a boost in productivity for wealthy farmers benefit the poor in the developing world? Superficially, a move like the introduction of Roundup Ready soy to U.S. farmers would help the Third World poor, since about 35 percent of U.S. soybeans are destined for export (Environmental Working Group 2003). But as Amartya Sen (1981; 1999) has demonstrated thoroughly, starvation is not correlated with the underproduction of food, and is rarely caused by it. The case is clearest with incidents of famine. Famines can occur when food production is at its peak, and food production can drop as much as 70 percent in a poor region without triggering a famine (Sen 1999). What matters is people's access to food. In many of the most notorious famines, starvation occurred among a particular economic class because of a drop in the value of their product relative to the price of staple grains. One common way for this to happen is for prices of commodity crops like soybeans to drop precipitously. For instance, in the Bengali famine of 1943, fishermen starved because of a drop in the price of fish relative to rice (Sen 1999). So, as Nottingham (1998) points out, the use of GMOs by First World farmers is likely to increase starvation by undercutting the incomes of Third World farmers.

To deal with justice issues in human germ-line enhancement, I take both my conceptual framework and my basic arguments from Allen Buchanan and his colleagues (2000). Buchanan and colleagues split the

justice arguments surrounding human genetic enhancement into issues of distributive justice and the morality of inclusion. The distributive justice arguments center, obviously, on how germ-line enhancements should be distributed (see, e.g., Lappé 1991 or Munson and Davis 1992). The morality of inclusion arguments ask how the unenhanced or differently enhanced will be treated if we do not distribute enhancements identically. In a certain sense, these considerations are two sides of the same coin, but distributive justice arguments and the morality of inclusion arguments often point to different solutions. Distributive justice arguments take the structure of society for granted, and ask us to distribute genetic wealth in order to allow everyone equal access to social goods. Morality of inclusion arguments, which typically come from the disability rights movement, take for granted the distribution of genetic wealth and ask us to change society to allow everyone equal access to social goods. In either case, there is an underlying assumption that if we cannot deal with these justice issues effectively, we should not engage in genetic enhancement at all. These arguments often are dramatized by extreme science fiction scenarios in which a genetically enhanced overclass oppresses an unenhanced, or even deliberately cognitively disabled, underclass. Here I use a different scenario, taken from Buchanan and colleagues (2000, p. 196). Suppose a genetic intervention is able to enhance dramatically the immune system of those who have access to it, so that they are sick less often and less severely. A minority who do not have access to this intervention might be shut out of the labor market because of decreased available sick days or employer discrimination. Excluded from a crucial aspect of society, the unenhanced are considered less than persons.

The deliberations of Buchanan and his colleagues are complex, but one can draw a simple lesson from them: the important justice considerations in human genetic engineering do not come from the treatment/enhancement distinction; they come from the principles of distributive justice and the morality of inclusion themselves. Distributive justice typically requires some kind of equality of opportunity. Applied to human genetic engineering, this means that everyone be provided a "decent genetic minimum" (Buchanan et al. 2000, p. 81), although by no means does this require that we all have the same genotype. Furthermore, all the accounts of distributive justice allow individuals to pursue enhancements and even require public funding for some of them. The immune system enhancement I mentioned earlier should be actively promoted by the government, just as vaccines are now. Buchanan and colleagues also suggest that justice

would require public funding for a cognitive enhancement that works best on normal but poorly performing students. The only times enhancements are impermissible are when they are self-defeating, pose threats to public goods, or are unfair. There is no point in engaging in an arms race over height, for instance.

The morality of inclusion also does not outlaw enhancement. It asks us sometimes to change social structures to allow greater access for the unenhanced or differently enhanced, rather than providing universal enhancement. This obviously sometimes will be necessary because not everyone will agree on what constitutes an enhancement or consent to genetic modification of their offspring. On the other hand, Buchanan and colleagues point out that altering society cannot always be the solution for unequal access because sometimes there are gains to be had from social structures that are difficult to access. Their example is choosing a card game to be played by people ranging in age from 5 to 50. Go Fish would be more inclusive, but contract bridge would be more enjoyable for the adults (Buchanan et al. 2000, p. 288).

To deal with human germ-line enhancement, then, will require a combination of public funding for free distribution of enhancements and tailoring of social structures so they continue to include the unenhanced. None of this precludes enhancement altogether. Thus, the justice arguments yield the same results for both human and nonhuman germ-line enhancement: manage the technology to conform with the principles of justice, but do not ban it.

TRUST ARGUMENTS

Philosophers are not used to having to evaluate the trustworthiness of their partners in various debates. Nevertheless, the debate about germline enhancement takes place in the real world. A loose regulatory environment requires a climate of trust, and we can evaluate whether such a climate exists for germ-line enhancement. Again, the need for a tight regulatory environment is equally present in the human and the nonhuman case.

One of the largest producers of genetically modified nonhuman organisms is Monsanto, Inc. Before Monsanto was a "life sciences" company, it was a chemical company, with an astonishingly poor environmental record. From 1935 to 1977, Monsanto was the only company in the U.S. to manufacture polychlorinated biphenyls (PCBs), which are now illegal because of their environmental hazards. From 1941 to 1971, Monsanto operated a plant that produced PCBs in Anniston, Alabama. Discharge

from the plant and toxic dumps in largely African-American West Anniston have thoroughly poisoned the soil and water. Company tests found levels of PCBs in fish caught near Anniston to be 7,500 times the legal limit (Grunwald 2002). Internal company documents reveal that Monsanto knew about the danger of their emissions and covered it up (Grunwald 2002; Environmental Working Group 2002). In 1966, the company hired a scientist to test the water in a creek near the town. The researcher released 25 fish into the water. The fish "lost equilibrium and turned on their sides in 10 seconds and all were dead in three and a half minutes" (Sack 2002). When Monsanto became a genetics company, management spun off the Anniston plant to a company called Solutia, which has since become a lawsuit magnet.

The trust argument asks whether companies like Monsanto will act in the public interest if they are restrained only by market forces and their own conscience. U.S. regulatory policy, which still relies heavily on self-reporting, seems to assume that a climate of trust is justified. Given the track record of the players involved, I cannot see how that is true.

Trust issues in human germ-line enhancement come from the shadow of eugenics. The history of eugenics is well known: Before World War II it was common for people of all political stripes to believe that the human gene pool should be improved by encouraging breeding among desirable people and discouraging it among undesirables. After WWII, with the publication of the Nazi crimes, it ceased to be acceptable to advocate eugenics.

To see whether the eugenics movement taints contemporary genetic technology, one first needs a complete accounting of everything that was wrong with eugenics. Surprisingly, there is not much agreement on this. The answer cannot be that eugenics was interested in enhancement, because the vast majority of the abuses, including all of the crimes against humanity, were committed in the name of *negative* eugenics (Buchanan et al. 2000). The problem is that eugenics was immoral in so many ways, that it is impossible to identify a single failing as the crime of eugenics. It is easy enough to pick out a factor like racism, the belief that the good of populations outweighs the good of individuals, or even just a poor understanding of heredity. But clearly these are not the only factors. James Watson, Nobel laureate and codiscoverer of the structure of DNA, argues that the real problem was the use of coercive measures by the state—sterilization, murder, and the like—and that the solution is to keep state regulation as far from genetic policy as possible (in Stock and Campbell

2000). However, the state is not the only source of coercion, and not all harms can be labeled forms of coercion. Indeed the most likely restrictions of freedom to come from contemporary genetic science will be the effect of market forces. Buchanan and colleagues, following Daniel Kevles (1985), suggest that the problem with eugenics was the failure to respect justice.

All of the above accounts contain a measure of truth. Once again, the solution is regulation. Society will need to control the market for genetic technology so that coercion is avoided and justice is respected. However, it also is important that the people currently promoting human genetic engineering are not like the people involved in eugenics. The comments of many involved in genetic science are not reassuring. Watson told a panel of geneticists at UCLA:

> I'm afraid of asking people what they think [of germ-line therapy]. Don't ask Congress to approve it. Just ask them for money to help their constituents. That's what they want—money to help their constituents. They don't want to deal with diabetes. They don't want Parkinson's. Frankly, they would care much more about having their relatives not sick than they do about ethics and principles. (Stock and Campbell 2000, p. 84)

Watson is candid here, as usual: He wants the government to give him a pile of money and go away. This would be a bad idea.

NATURALNESS ARGUMENTS

Naturalness arguments include any argument that assigns special moral status to an entity because it is natural. Here I am thinking of arguments that assign value to species or ecosystems apart from the organisms that make them up, the species boundary, or the capacities of the human organism as it evolved in the Pleistocene. I also include any argument that depends on the notion of "playing God." Again I argue by example, looking at two writers who use naturalness arguments, Vandana Shiva (2000) and Leon Kass (2002). Although the former is regarded as an archliberal and the latter as an archconservative, they have much in common.

Both Shiva and Kass fear the ascendancy of a worldview that they label "reductionism." Many ideas get hidden under this rubric. Here I distinguish three—genetic determinism, genetic reductionism, and commodification—leaving the unmodified word "reductionism" as the umbrella term. Genetic determinism is a causal thesis. It can range from the false claim that genes act independently of the environment to create traits to the possibly

true claim that genes deserve a place of prominence in the explanation of most traits. Shiva spends a fair amount of time denouncing this sort of determinism, which she sees as the basis for the claims of power made by agricultural biotechnology companies. Kass is less concerned with the causal thesis. In fact, Kass is afraid that a more sophisticated version might be true, eliminating any practical barriers to the commodification of humankind.

Genetic reductionism, by contrast, is a class of moral theses. It covers any claim that equates the purpose or identity of an organism with its genes. Both Kass and Shiva are extremely concerned about this thesis, as witnessed by their attacks on the rhetoric of Richard Dawkins (1989). The real terror of reductionism, however, is the commodification of life. Both Kass and Shiva worry extensively that life is now going to be thought of as a "resource" or "raw material" for the engines of production and consumption. There are some interesting differences, though. Kass is concerned only with the application of reductionism to one kind of animal, humans. Indeed, when he speaks of reductionism, he often means the reduction of humans to the status of other animals, rather than the reduction of life to the status of machines. Shiva, by contrast, worries about the commodification of nonhuman life, but her language shows that she is interested in nonhuman life in an odd way. She speaks of viewing "species" as mere commodities, and of failing to recognize their "intrinsic worth." The implication is that species are valuable apart from the individuals that make them up.

Rather than attempt to spin the worries into an argument and then refute it, I argue that reductionism itself is not something to worry about. In order for the reductionism in question to be fearsome, one must make an assumption about the value of nature as it is given, either human nature or the environment. The core worry for both Shiva and Kass is commodification, but what exactly is being commodified? Shiva's worry is not about the possible suffering of individual animals. She includes the value of microorganisms in the value of species, and microorganisms cannot suffer. Shiva's worry is that the integrity of the species will be violated because their boundaries are no longer set by nature, but subject to human control. But this is only a problem if one assumes that the species boundary was sacrosanct to begin with, and there is no reason to think this. Species boundaries are the product of blind evolution; they were not drawn up with any purpose in mind. If we can alter species boundaries for the better, so be it.

Something similar is going on in Kass's notion of commodification. Kass's core worry is not about any of the elements of human well being. His concern is not about how human beings will be altered; it is rather the fact that human beings will be altered at all. Such alterations are an affront to our dignity. But again, one only can believe this if one perceives something special about human nature as it is given. And again, there is no reason to think this is so. Human nature was determined by what survived long enough to reproduce in Africa 150,000 years ago. There is no reason to think that this is the best, or even a particularly good, way to be. Here, I agree with Watson: "Evolution can be damn cruel" (Stock and Campbell 2000, p. 85).

So Shiva and Kass share something important: They both think there is something intrinsically ethically important about species as they have evolved. Shiva and Kass phrase their worries in terms of commodification, which makes their argument appealing. But not all control is commodification. Buchanan and colleagues (2000) write about the "colonization of the natural by the just." Previously genes were not under human control, and hence not a part of justice. Control of genes could mean rule by goodness.

CONCLUSION

Of the four classes of argument regarding germ-line enhancement examined here, the first three have moderately successful instances, which call for equal amounts of caution and regulation in the pursuit of both human and nonhuman genetic engineering. It is the final class of arguments, the naturalness arguments, that seems to account for the difference in attitude toward human and nonhuman genetic engineering. If successful, such arguments could justify a total ban on germ-line genetic enhancement and would apply more strongly to humans than nonhumans. Naturalness arguments fail, however. Consequently, the discrepancy in attitude toward human and nonhuman germ-line enhancement is unjustified.

NOTE

1. Of course, the genetic modification would not be necessary if people simply stopped eating meat, but as long as people do eat meat, the modification probably would be a good thing.

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