
An Article Submitted to

*Studies in Ethics, Law, and
Technology*

Manuscript 1110

Ethics of Human Enhancement: 25
Questions & Answers

Fritz Allhoff*

Patrick Lin[†]

James Moor[‡]

John Weckert**

*Western Michigan University, fritz.allhoff@wmich.edu

[†]California Polytechnic State University, palin@calpoly.edu

[‡]Dartmouth College, james.h.moor@dartmouth.edu

**Charles Sturt University, jweckert@csu.edu.au

Ethics of Human Enhancement: 25 Questions & Answers*

Fritz Allhoff, Patrick Lin, James Moor, and John Weckert

Abstract

This paper presents the principal findings from a three-year research project funded by the US National Science Foundation (NSF) on ethics of human enhancement technologies. To help untangle this ongoing debate, we have organized the discussion as a list of questions and answers, starting with background issues and moving to specific concerns, including: freedom & autonomy, health & safety, fairness & equity, societal disruption, and human dignity. Each question-and-answer pair is largely self-contained, allowing the reader to skip to those issues of interest without affecting continuity.

KEYWORDS: human enhancement, human engineering, nanotechnology, emerging technologies, policy, ethics, risk

*The authors of this report gratefully acknowledge the support of the US National Science Foundation (NSF) under awards #0620694 and 0621021. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the NSF. We also acknowledge our respective institutions for their support: Dartmouth College and Western Michigan University, which are the recipients of the NSF awards referenced above, as well as California Polytechnic State University and Australia's Centre for Applied Philosophy and Public Ethics. In writing this report, we have benefited from discussions and presentations from many colleagues and friends during the course of our three-year investigation, which include workshop participants at Dartmouth College (April 14-15, 2007) and conference participants at Western Michigan University (March 28-29, 2009). Special thanks go to Dr. Tom Powers at the University of Delaware for his gracious support through Delaware NSF-EPSCoR grant #EPS-0447610. Thanks also to our editorial assistant, Lindsay Mouchet. We are indebted to two anonymous reviewers from this journal and its editors—Bert Gordijn and Mark Cutter—for valuable feedback on an earlier draft. Finally, we thank our families as well as the broader public whose hopes and concerns highlight the role that ethics must play in guiding the development and use of human enhancement technologies—inescapably a part of all our futures.

“Man is the only creature that refuses to be what he is.”—Albert Camus (1951, p.11)

A. Introduction

Homo sapiens has been such a prolific species, simply because we are very good at relentlessly adapting to our environment. At the most basic level, we have won control over fire and tools to forge a new world around us, we build shelter and weave clothes to repel the brutal elements, and we raise animals and crops for predictability in our meals. With our intellect and resourcefulness, we are thereby better able to survive this world.

However, it is not just the world around us that we desire to change. Since the beginning of history, we also have wanted to become more than human, to become *Homo superior*. From the godlike command of Gilgamesh, to the lofty ambitions of Icarus, to the preternatural strength of Beowulf, to the mythical skills of Shaolin monks, and to various shamans and shapeshifters throughout the world’s cultural history, we have dreamt—and still dream—of transforming ourselves to overcome our all-too-human limitations.

In practice, this means that we improve our minds through education, disciplined thinking, and meditation; we improve our bodies with a sound diet and physical exercise; and we train with weapons and techniques to defend ourselves from those who would conspire to kill. But today, something seems to be different. With ongoing work to unravel the mysteries of our minds and bodies, coupled with the art and science of emerging technologies, we are near the start of the Human Enhancement Revolution.

Now we are not limited to “natural” methods to enhance ourselves or to merely wield tools such as a hammer or binoculars or a calculator. We are beginning to incorporate technology within our very bodies, which may hold moral significance that we need to consider. These technologies promise great benefits for humanity—such as increased productivity and creativity, longer lives, more serenity, stronger bodies and minds, and more—though, as we will discuss later, there is a question whether these things translate into *happier* lives, which many see as the point of it all (President’s Council on Bioethics, 2003; Persaud, 2006).

As examples of emerging technologies in the last year or so, a couple imaginative inventions in particular, among many, are closing the gap even more between science fiction and the real world. Scientists have conceptualized an electronic-packed contact lens that may provide the wearer with telescopic and night vision or act as an omnipresent digital monitor to receive and relay information (Parviz, et al., 2008). Another innovation is a touch display designed to be implanted just under the skin that would activate special tattoo ink on one’s

arm to form images, such as telephone-number keys to punch or even a video to watch (Mielke, 2008). Together with ever-shrinking computing devices, we appear to be moving closer to cybernetic organisms (or “cyborgs”), that is, where machines are integrated with our bodies or at least with our clothing in the nearer-term. Forget about Pocket PCs, mobile phones, GPS devices, and other portable gadgets; we might soon be able to communicate and access those capabilities without having to carry any external device, thus raising our productivity, efficiency, response time, and other desirable measures—in short, enabling us to even better survive our world.

Technology is clearly a game-changing field. The invention of such things as the printing press, gunpowder, automobiles, computers, vaccines, and so on, has profoundly changed the world, for the better we hope. But at the same time, they have also led to unforeseen consequences, or perhaps consequences that might have been foreseen and addressed had we bothered to investigate them. Least of all, they have disrupted the status quo, which is not necessarily a terrible thing in and of itself; but unnecessary and dramatic disruptions, such as mass displacements of workers or industries, have real human costs to them. As we will discuss, this may well be the case with human enhancement technologies, enabled by advances in nanotechnology, micro-electro-mechanical systems (MEMS), genetic engineering, robotics, cognitive science, information technology, pharmacology, and other fields (Roco and Bainbridge, 2003).

In this paper, we examine many ethical and social issues surrounding human enhancement technologies. For instance, on the issue of whether such technologies ought to be regulated or otherwise restricted, one position is that (more than minimal) regulation would hinder personal freedom or autonomy, infringing on some natural or political right to improve our own bodies, minds, and lives as we see fit (Naam, 2005; Bailey, 2005; Harris, 2007; Allhoff et al., forthcoming). Others, however, advocate strong regulation—and even a research moratorium—to protect against unintended effects on society, such as the presumably-undesirable creation of a new class of enhanced persons who could outwit, outplay, and outlast “normal” or unenhanced persons for jobs, in schools, at sporting contests, and so on, among other reasons (Fukuyama, 2003, 2006; Friends of the Earth, 2006). Still others seek a sensible middle path between stringent regulation and individual liberty (Hughes, 2004; Greely, 2005).

No matter where one is aligned on this issue, it is clear that the human enhancement debate is a deeply passionate and personal one, striking at the heart of what it means to be human. Some see it as a way to fulfill or even transcend our potential; others see it as a darker path towards becoming Frankenstein’s monster. To help untangle this debate, we have organized this report as the following list of questions and answers, starting with background issues and

moving to specific concerns, including: freedom & autonomy, health & safety, fairness & equity, societal disruption, and human dignity.

Each question-and-answer pair is largely self-contained, allowing the reader to skip to those issues of interest without affecting continuity much. In doing so, we are mindful of our audience, which we take to be primarily the broader public who is not as familiar with the human enhancement debate but interested in engaging it. At the same time, we offer original analysis that academics and other experts in the field may find useful.

These discussions are not exhaustive; indeed, many of these questions would require a book-length treatise for any satisfying answer. Rather, we intend for this report to broadly survey the human enhancement landscape and its main contours, not its more intricate rabbit holes and subtler terrain, as other and future investigations will explore.

B. Definition & Distinctions

1. What is human enhancement?

To begin with, we need to draw several important distinctions.¹ Strictly speaking, “human enhancement” includes any activity by which we improve our bodies, minds, or abilities—things we do to enhance our well-being. So reading a book, eating vegetables, doing homework, and exercising may count as enhancing ourselves, though we do not mean the term this way in our discussion here. These so-called “natural” human enhancements are morally uninteresting because they appear to be unproblematic to the extent that it is difficult to see why we should not be permitted to improve ourselves through diet, education, physical training, and so on; yet it is still an open question whether emerging, engineered enhancements might or ought to be unproblematic as well.

Rather, allow us to stipulate for the moment that “human enhancement” is about boosting our capabilities *beyond the species-typical level or statistically-normal range* of functioning for an individual (Norm Daniels, 2000). Relatedly, “human enhancement” can be understood to be different from “therapy”, which is about treatments aimed at pathologies that compromise health or reduce one’s level of functioning below this species-typical or statistically-normal level (Eric Juengst, 1997). Another way to think about human enhancement technologies, as opposed to therapy, is that they change the structure and function of the body (Greely, 2005). Admittedly, none of these definitions is immune to objections, but

¹ We recognize that some advocates of human enhancement argue against making such a distinction, especially between therapy and enhancement (*e.g.*, Bostrom and Roache, 2008), which seems to more easily justify unrestricted human enhancement. Even if this position is tenable, we do not want to take that point for granted here, which we will discuss in question 4 below.

they are nevertheless useful as a starting point in thinking about the distinction, including whether there really is such a distinction.

Thus, corrective eyeglasses, for instance, would be considered therapy rather than enhancement, since they serve to bring your vision back to normal; but strapping on a pair of night-vision binoculars would count as human enhancement, because they give you sight beyond the range of any unassisted human vision. As another example, using steroids to help muscular dystrophy patients regain lost strength is a case of therapy; but steroid use by otherwise-healthy athletes would give them new strength beyond what humans typically have (thereby enabling them to set new performance records in sports). And growing or implanting webbing between one's fingers and toes to enable better swimming changes the structure and function of those body parts, counting then as a case of human enhancement and not therapy.

Likewise, as it concerns the mind, taking Ritalin to treat attention-deficit hyperactivity disorder (ADHD) is aimed at correcting the deficit; but taken by otherwise-normal students to enable them to focus better in studying for exams is a form of human enhancement. And where reading a book may indeed make you more knowledgeable, it does not make you so much smarter than most everyone else or push your intellect past natural limits; on the other hand, a computer chip implanted into your brain that gives you direct access to Google or spreadsheets would provide mental capabilities beyond the species-typical level.

2. Is the natural-artificial distinction morally significant in this debate?

As we mentioned, strictly speaking, human enhancements seem to include such activities as reading a book, eating vegetables, doing homework, and exercising. To the extent that these "natural" enhancements are ethically unproblematic, it would be tempting to draw a line here in the human enhancement debate such that "artificial" or "unnatural" enhancements require moral evaluation.

However, the natural-versus-artificial distinction, as a way to identify human enhancements, may prove most difficult to defend given the vagueness of the term "natural." For instance, if we can consider X to be natural if X exists without any human intervention or can be performed without human-engineered artifacts, then eating food (that is merely found but perhaps not farmed) and exercising (*e.g.*, running barefoot but not lifting dumbbells) would still be considered natural, but reading a book no longer qualifies as a natural activity (enhancement or not), since books do not exist without humans.

Or if we allow that some human-dependent things can be natural, *e.g.*, a flint axe or book, depending on their level of complexity or the amount of engineering required, this seems to specify an arbitrary requirement which too may be difficult (but not impossible?) to defend. If we want to say that reading

books is generally a form of natural enhancement (because books are not as complex to create as, say, a computer), would some books that are difficult to write or have taken years of research then count as *artificial* enhancements? What about reading a simple e-book on Amazon's Kindle™, which is a clearly a complex and engineered device?

Further, the natural-artificial distinction often rests on theological or teleological premises, *i.e.*, that we have God-given goals or limits in life such that being able to lift 500 pounds over one's head or living to age 300 is profanely unnatural and in violation of nature or God's will. We do not wish to be mired in such theological issues, as important as they are to theists, though we return briefly to them in question 16.

3. Is the internal-external distinction morally significant in this debate?

The previous examples suggest a further distinction we should make. By "human enhancement" we do not mean the mere use of tools, as this would render the concept impotent, turning nearly everything we do into cases of human enhancement. But if and when these tools are integrated into our bodies, rather than employed externally, then we will consider them to be instances of human enhancement (by stipulation again, for the moment). Of course, this raises the question: What is so special about incorporating tools as part of our bodies, as opposed to merely using them externally to the body (Bostrom and Roache, 2008)? That is, why should the former count as human enhancement, but not the latter? A neural implant that gives access to Google and the rest of the online world does not seem to be different *in kind* to using a laptop computer or Pocket PC to access the same, so why should it matter that we are imbedding computing power into our heads rather than carrying the same capabilities with us by way of external devices?

We will not attempt to give a full discussion of that point here, though it will be important to explore the issue further, except to suggest that integrating tools into our bodies (and perhaps with our everyday clothing to the extent that we are rarely without our clothes) appears to give us unprecedented advantages which may be morally significant. These advantages include having easier, immediate, and "always-on" access to those new capabilities as if they were a natural part of our being; we would never be without those devices, as we might forget to bring a laptop computer with us to a meeting. And assimilating tools into our persons creates an intimate or enhanced connection with our tools that evolves our notion of personal identity, more so than simply owning things (as wearing name-brand clothes might boost one's sense of self). This may translate into a *substantial* advantage for the enhanced person, more so than gained by purchasing an office computer or reading books or training with the best coaches.

Therefore, we might reasonably understand the distinction between human enhancement and mere tools by looking for an always-on (*i.e.*, on-demand or permanent) feature, as opposed to the temporary or contingent access of our daily gadgets and tools (*e.g.*, a mobile phone can be easily lost, stolen, or left behind). But even so, this attempt at a definition still needs further defense, as there are grey areas that need to be resolved.

For instance, one grey area is that of “smart clothes”—clothing with devices embedded into them, or clothing made from new, dynamic materials that may also serve as armor or for medical purposes. If making a device permanent by embedding or integrating it into our bodies is considered human enhancement, then it is not clear whether such clothing ought to count as enhancement as well. On one hand, clothes can be cast aside like an Apple iPhone™, for instance, and (or because) they are external to us; yet we are almost never without clothes, which may not be so easy to shed once they are on. So while smart clothes may not be as permanent as, say, a computer chip implanted in one’s brains, they may approximate the always-on or 24/7 access characteristic that, we stipulate, tracks the enhancement-versus-mere tools distinction. Eyeglasses, too, that are not cumbersome to wear all day (*e.g.*, in contrast to bulky, night-vision goggles today) and that give us super-vision or double as a computer display might plausibly be called an enhancement. Therefore, we do not recognize the central distinction in this debate as between internal or implanted tools and tools external to our bodies, which is a distinction that seems to carry less *prima facie* moral relevance and would need greater argument to establish.

This is not to say that an enhancement-versus-tools distinction is ultimately defensible or not, but only that it does not help an early investigation into the ethics of using such technological innovations—whatever we want to call them—to consider “enhancement” so broadly that it obscures our intuitive understanding of the concept and makes everything that gives us an advantage in life into an enhancement.

If our considered distinction here cannot ultimately be defended—that is, if there is no moral significance in using an enhancing device internally or externally to our bodies—then the implication is that all tools, from hammers to hardhats and from cars to computers, ought to be recognized as forms of human enhancement. And there’s a *prima facie* case to be made that, if hammers and computers can be used without moral risk, then more fantastical tools, *e.g.*, neural implants or gene therapy to halt aging or give superhuman strength, should also be morally permissible. However, this is not the end of the debate, since we might agree that human enhancement technologies *per se* are not morally problematic, but their use in certain applications or areas of life could still be questionable.

4. *Is the therapy-enhancement distinction morally significant in this debate?*

Returning to an issue previously raised in question 1—and as a perhaps more critical distinction to elucidate—some scholars have reasonably objected that there is no real distinction between therapy and enhancement, which would mean that our working definition is inadequate. For instance, how should we think about vaccinations: are they a form of therapy, or are they an enhancement of our immune system (Daniels, 2000; Harris, 2007; Bostrom and Roache, 2008)? On one hand, a vaccination seems to be an enhancement in that there is no existing pathology it is attempting to cure, merely a possible or likely pathology we wish to avoid; but we are drawn to declare it as some form of therapy—perhaps preventative therapy—given its close association with medicine? And if enhancements in general are ultimately found to be socially or ethically problematic, then counting vaccinations as enhancement opens the possibility that it should be regulated or restricted, which would create a serious public health disaster as well as a counter-example to the claim that enhancements are problematic. Thus, even critics of human enhancement may be loathe to put vaccinations in the enhancement bucket, though there does not seem to be an obviously superior reason to think otherwise.

Another dilemma: If a genius were to sustain a head injury, thereby reducing her IQ to merely the “average” or “species-normal” range, would raising her intelligence back to its initial “genius” level count as therapy or enhancement (Bostrom and Roache, 2008)? Either one would seem plausible, but is there a non-arbitrary reason for answering the question either way? If an enhancement, then how do we explain the difference between that and a clear (or clearer) case of therapy in which we return an “average” person who sustains a head injury back to the “normal” IQ range?

The therapy-enhancement distinction holds real stakes, beyond athletic and academic competition. Recent news reports show that the US military is increasingly prescribing anti-depressants to soldiers in combat to alleviate post-traumatic stress as well as stimulants to counteract sleep deprivation—actions which could be viewed as either creating a more effective, level-headed soldier or returning the soldier to the initial “normal” state of combat readiness, further blurring the distinction (M. Thompson, 2008; Saletan, 2008).²

The above cases notwithstanding, we would agree that there are difficulties in precisely defining “human enhancement” (as there is with making clear definitions of nearly any other concept), but maintaining the enhancement-

² However, if the military were to prescribe such medications *prior* to combat, then one could make the case for counting that as an enhancement; but this may take us full circle back to the vaccination question, particularly as soldiers are routinely vaccinated against bio-threats such as anthrax.

therapy distinction, at least until it can be more fully explored, is nonetheless important for several reasons:

First, to the extent that pro-enhancement advocates are primarily the ones arguing against the therapy-enhancement distinction, if a goal is to engage the anti-enhancement camp, then it would make for a far stronger case to meet those critics on their own ground (*i.e.*, to grant the assumption that such a distinction exists). If it proves overly charitable to grant this assumption such that the pro-enhancement position is too difficult to defend without it, then perhaps more attention needs to be paid in arguing against the distinction in the first place, given that the debate may hinge on this fundamental issue.

Second, by not making these distinctions, specifically between therapy and enhancement, it may be too easy to argue that all forms of human enhancement are morally permissible given that the things we count as therapy are permissible. That is to say, we risk making a straw man argument that does not make a compelling case either for or against any aspect of human enhancement. Again, if the human enhancement debate turns on this distinction, then much more attention should be paid to defending or criticizing the distinction than has been to date.

Third, at least part of the reason that human enhancement is believed by both sides of the debate to be the most important controversy in science and society this new century (Hurlbut, 2006) seems to be that it represents a collision between our intuitions and our actions. For instance, critics may believe that human enhancement technologies give an unfair advantage to some persons, fracturing local or global societies (even more) between the haves and have-nots (Fukuyama 2002, 2006; President's Council on Bioethics, 2003; Selgelid, 2007). Yet, at the same time, they seem to endorse—to the extent that they have not raised objections to—our use of existing technologies (*e.g.*, mobile phones, computers, Internet) that also seem to countenance the same division to which human enhancement technologies are said to lead us.

As another example, advocates of human enhancement may believe that individual autonomy should trump health and safety concerns, *e.g.*, athletes should be permitted to take steroids or adults should be allowed to take mood-enhancing drugs at will (Naam, 2005; Savulescu and Foddy, 2007). Yet, at the same time, they do not offer objections to keeping some drugs illegal, such as crystal meth or crack cocaine, which becomes an even more complicated dilemma if they advocate legalizing other contraband such as marijuana.

This is not to say that these tensions with our intuitions are irresolvable, but only that “common sense” is at stake for both sides of the debate. And the initial intuition for the overwhelming majority of us is that there *is* a therapy-enhancement distinction (since we understand “therapy” and “enhancement” as meaningfully discrete terms, even if some cases do not neatly fit into either

category). So it would be more interesting for pro-enhancement advocates to reconcile their position with that intuition, if possible, rather than to reject the distinction, which is less satisfying. Or if the therapy-enhancement distinction really is untenable, then more vigorous argument seems to be needed before we are prepared to cast aside our intuition.

Fourth, the famous philosophical puzzle “The Paradox of the Heap” should be recalled here: Given a heap of sand with N number of grains of sand, if we remove one grain of sand, we are still left with a heap of sand (that now only has $N-1$ grains of sand). If we remove one more grain, we are again left with a heap of sand (that now has $N-2$ grains). If we extend this line of reasoning and continue to remove grains of sand, we see that there is no clear point P where we can definitely say that a heap of sand exists on one side of P , but less than a heap exists on the other side. In other words, there is no clear distinction between a heap of sand and a less-than-a-heap or even no sand at all. However, the wrong conclusion to draw here is that there is no difference between them or that the distinction between a heap and no-heap should be discarded (or between being bald and having hair, as a variation of the paradox goes). Likewise, it would seem fallacious to conclude that there is no difference between therapy and enhancement or that we should dispense with the distinction. It may still be the case that there is no *moral* difference between the two, but we cannot arrive at it through the argument that there is no clear defining line or that there are some cases (such as vaccinations, etc.) that make the line fuzzy. As with “heap”, the terms “therapy” and “enhancement” may simply be vaguely constructed and require more precision to clarify the distinction (Buyx, 2008).

Therefore, at least for the time being and for the purposes of this report, we will assume that a therapy-enhancement distinction is defensible and illuminative, at least where it aligns with our intuitions. Even if it is not, again, this does not mean the end of the human enhancement debate: it could still be that some enhancements (and therapies) are morally problematic in certain applications or areas of life, *i.e.*, contexts may matter.

C. Contexts & Scenarios

5. *Why would contexts matter in the ethics of human enhancement?*

We allow that it may ultimately be the case that the therapy-enhancement distinction may be shallow and/or that enhancements *per se* are not morally relevant; but we leave those as open questions to be explored in this embryonic stage of the debate. It is possible, and perhaps likely, that human enhancements need to be considered separately according to their type or application in an ethics investigation. So, for instance, even if we do not consider vaccines as

preventative therapy (which may be the more natural way to see it) but view them as enhancements of our immune system, that does not imply that *all* enhancements are morally unproblematic.

What counts as an enhancement and whether it is morally relevant seems to be context-dependent. For example, we can imagine a society in which strict equality is the all-important value, trumping individual rights to life, liberty, knowledge, and so on; thus immunizing a person from a serious disease might be prohibited in such a world, so to not upset egalitarian values or disrupt social institutions that strongly rely on a certain range of life expectancy, *e.g.*, a social security system. Another example: freely burning fossil fuels was less morally significant in 1910 than it is in 2010, given our current awareness of global warming, pollution, and their causes and effects. Therefore, context matters, and so it seems premature to say that all enhancement are morally worrisome, irrespective of context; but it is also premature to declare all of them to be unproblematic, especially at a start of debate exactly about those questions.

For a similar reason, it does not really help to dismantle or obviate the therapy-enhancement distinction by claiming that “everything good is an enhancement” as we first considered in question 1—that education, diet, exercise, etc. are all enhancements, and because these instances are unobjectionable, then no enhancement is intrinsically problematic. Besides being a loose generalization, we could make an argument that even education, diet, etc. *do* have ethical implications (in that they may create inequities among individuals), but that these implications are outweighed by other considerations, such as liberty, the value of self-improvement, and so on; and that is why education, diet, etc. are unobjectionable, all things considered.

Or we can make an argument that strict equality is not morally required in the first place, given the natural and manageable range of variations in our species; but if some future vaccine takes us well beyond this “normal” range, *e.g.*, super-longevity or super-strength, our social systems (including law and public policy) are not equipped to account for those extra abilities, thereby raising latent issues of equity, fairness, access, etc. back to the forefront. Similarly, we can imagine a world in which cognitive enhancements no longer hold much controversy as they do today, after social structures in the future have adapted to account for them—just like, *e.g.*, steroid use in sports might no longer be an ethical issue (perhaps only a health issue) if we create separate competitions for the enhanced as well as unenhanced. Again, context seems to matter.

6. *What are some examples of enhancement for cognitive performance?*

In the area of improving mental performance, individuals are already using pharmaceuticals available today to achieve such goals as increased productivity,

creativity, serenity, and happiness. We previously mentioned Ritalin use, intended for ADHD patients, by otherwise-normal students to boost concentration as a way to study more effectively. In sports, drugs such as beta-blockers, intended to treat high blood pressure and other disorders by slowing down the heart rate, have been used to reduce anxiety as a way to boost physical performance, such as in preparing for an important and nerve-racking putt in golf or steadying an archer's hand to better release the arrow in between heartbeats. In warfare, anti-depressants and stimulants have been used to treat post-traumatic stress and sleep deprivation, thereby creating better, more effective soldiers. And, of course, hallucinogenic and other recreational drugs, including alcohol, continue to be used (and used famously by some authors and artists) to achieve greater creativity, relaxation, and even enlightenment.

In the future, as technology becomes more integrated with our bodies, we can expect neural implants of the kind we mentioned above that effectively puts computer chips into our brains or allows devices to be plugged directly into our heads, giving us always-on access to information as well as unprecedented information-processing powers. New and future virtual reality programs are able to much better simulate activities, for instance, to train law enforcement officers and soldiers in dangerous situations so that they can respond better to similar events in the real world.

7. What are some examples of enhancement for physical performance?

In the area of physical performance, steroids use by athletes is one of the most obvious examples. Cosmetic surgery has also grown in popularity, not for corrective purposes but to increase (perceived) attractiveness, and this has ethical and genetic implications (Scott, 2009). Prosthetic limbs have improved to such a degree that they are already enabling greater than normal strength and capabilities to those that use them, sparking a debate on whether athletes with those artificial limbs may participate in the Olympics (Edwards, 2008a).

In the future, we can expect continuing advances in robotics and bionanotechnology to give us cybernetic body parts, from bionic arms to artificial noses and ears, that surpass the capabilities of our natural body. Today, research organizations such as MIT's Institute for Soldier Nanotechnologies are working on an exoskeleton to give the wearer superhuman strength as well as flexible battlesuits that can, for instance, harden when needed to create a splint or tourniquet to attend to injuries more quickly and effectively (MIT, 2008). And we previously mentioned innovative designs such as for contact lenses that enable us to see in the dark or receive information from a miniature digital monitor. Further, designs have already been drawn for even more fantastic innovations such as a respirocyte: an artificial red blood cell that holds a reservoir of oxygen

(Freitas, 1998). A respirocyte would come in handy for, say, a heart attack victim to continue breathing for an extra hour until medical treatment is available, despite a lack of blood circulation to the lungs or anywhere else. But in an otherwise-healthy athlete, a respirocyte could boost performance by delivering extra oxygen to the muscles, as if the person were breathing from a pure oxygen tank.

And perhaps as an example of both mental and physical enhancement, we should also consider life extension, whether it comes by curing fatal pathologies (such as cancer) or rejuvenating the body/mind or developing anti-aging medicine, and whether it enables us to live another 20 or 100 or 1,000 years (radical life extension). This is a particularly contentious issue in the human engineering debate, not just for obvious concerns related to the burden of overpopulation on quality of life or loss of meaning in life, but also because it seems that we are already—and presumably unproblematically—extending our lives through better nutrition, medicine, exercise, sanitation, and so forth; yet there is something troubling to many about the prospect of radical life extension, even if we can all agree that, in principle, more life is better than less life. We will return to this in question 13 below.

8. Should a non-therapeutic procedure that provides no net benefit be called an “enhancement”?

Some applications of technology or modifications of our bodies may seem gratuitous, such as attempting to physically transform into a lizard by tattooing scales all over one’s body and forking one’s tongue, or into a cat by implanting whiskers, sharpening teeth and clipping one’s ears, or into something other than human with implanted horns in one’s forehead; all of these procedures have been done already. In the future, we can envision the possibility that prosthetic flippers, designed today for dolphins, along with artificial gills, etc., might be requested by humans who want to transform into an aquatic animal. This type of enhancement, of course, brings to the forefront the question whether “enhancement” is the right word to use in the debate in the first place, as opposed to simply “human engineering” or a more neutral term that does not imply improvement. Indeed, even in cases where technology boosts mental and physical capabilities, it seems that we cannot predict with any accuracy whether there will be any negative psychological or physiological side-effects that will offset the intended benefits of a particular enhancement. For instance, in drinking alcohol as a mood-enhancer of sorts, we already know that it can hold the unintended effect of a painful hangover, and steroids taken by athletes can have disastrous health consequences; in such cases, we cannot easily say the benefits outweigh the harms.

Moreover, if human enhancement can be ultimately defended, then *un-*enhancements may seem to be morally permissible as well, if individual autonomy is the most important value to consider in the debate (P. Thompson, 2008). There are already medical cases in which: individuals want to amputate some healthy limb from their bodies (Dyer, 2000); parents want to stunt the growth of their bedridden child to keep her portable and easier to care for (Edwards, 2008b); and deaf parents who specifically want a deaf baby in selecting embryos for *in vitro* fertilization (Dennis, 2004). Un-enhancements aside, we will continue to use “enhancement” in this report for the most part, since there is a presumption that whatever technology is integrated with our bodies will be expected to deliver some net benefit, real or perceived (otherwise, why do it?). Further, we will limit our discussion here primarily to those technologies that enhance human cognitive and physical abilities, rather than seemingly-gratuitous procedures or un-enhancements.

D. Freedom & Autonomy

9. Could we justify human enhancement technologies by appealing to our right to be free?

There is perhaps no greater value, at least in democracies, than the cherished concept of freedom, loosely defined here as the absence of constraints. But because freedom is central to the issue of human enhancement, it adds much fuel to the impassioned debate. Pro-enhancement advocates have argued against regulating enhancements on the grounds that it would infringe on our fundamental ability to choose how we want to live our own lives (Naam, 2005; Bailey, 2005; Harris, 2007). Or, in other words, if enhancing our bodies does not hurt anyone (other than possibly ourselves; more on this in question 10), then why should we be prevented from doing so? This is a common objection—arguing especially against governmental intervention—to any number of proposals that involve regulation, from hiring practices to home improvements to school clothing and so on.

Though freedom may be viewed in democracies as a “sacred cow” that ought not be corralled, the reality is that we do not have complete freedom in the areas of life that we think we do anyway. As examples, freedom of the press and freedom of speech do not protect the individual from charges of libel, slander, or inciting panic by yelling “Fire!” in a crowded theater; our privacy expectations quietly give way to security measures, such as searches on our property and persons at airports or eavesdropping on our communications; and even ancestral homes built by the hands of one’s forefathers could be unilaterally seized (and demolished) by the state under eminent domain laws. This is to say that whatever

rights we have also imply responsibilities and exist within some particular political system, therefore it is not unreasonable to expect or define certain limits for those rights, especially where they conflict with other rights and obligations.

Maximal freedom is a hallmark of a laissez-faire or minimal state, but a democratic society is not compelled to endorse such a stance, as some political philosophers have suggested (*e.g.*, Nozick, 1974). Nor would reasonable people necessarily want unrestricted freedom anyway, *e.g.*, no restrictions or background checks for gun ownership. Even the most liberal democracy today understands the value of regulations as a way to enhance our freedom. For instance, our economic system is not truly a “free market”: though we may advocate freedom in general, regulations exist not only to protect our rights, but also to create an orderly process that greases the economic wheel, accelerating both innovations and transactions. As a simpler example, by imposing laws on traffic, we can actually *increase* our freedom: by driving forward on only one side of the road, for instance, we can be (more) assured that we will not be a victim of a head-on collision, which makes driving faster a more sensible proposition.

There is another sense, related to free will, in which cognitive enhancements may be infringing: if an enhancement, such as a mood-altering drug or neural implant, interferes or alters our deliberative process, then it is an open question whether or not we are truly acting freely while under the influence of the enhancement. For instance, a “citizen chip” embedded in the brain might cause us to be unswervingly patriotic and hold different values than we would otherwise have. Further, external pressure from peers, employers, competitors, national security, and others to accept a particular enhancement also may unduly influence one’s decision making. (Guston, Parsi, and Tosi, 2007.)

10. *Could we justify enhancing humans if it harms no one other than perhaps the individual?*

To justify restrictions on our freedom and autonomy, of course, we would need strong, compelling reasons to offset that *prima facie* harm; specifically, we need to identify conflicting values that ought to be factored into our policymaking. One possible reason is that human enhancement technologies may pose a health risk to the person operated upon, similar to illegal or unprescribed steroids use by athletes: given how precious little we still know about how our brains and other biological systems work, any tinkering with those systems would likely give rise to unintended effects, from mild to most serious (President’s Council on Bioethics, 2003). Even drinking pure water—perhaps the safest thing we can do to our own bodies—may have some harms. For example, maybe we become dependent on fluoridated water to prevent tooth decay or drink too much water which dilutes sodium in the body to dangerously-low or fatal levels. Or consider

that many of the foods we eat everyday are suspected to have some causal connection to disease or unwanted conditions. It is therefore quite likely that making radical changes to our bodies undoubtedly will have surprising side-effects.

Is this reason enough to restrict human enhancement technologies, for the sake of protecting the would-be patient? The answer is not clear. Even if such technologies prove to be so dangerous or risky that we strongly believe we need to protect individuals from their own decisions to use those technologies (through paternalistic regulations), the well-informed individual might circumvent this issue by freely and knowingly consenting to those risks, thereby removing this reason to restrict use.

But even this case does not solve the conflict between autonomy and health/safety. First, it is not always clear whether a person's consent is sufficiently informed or not. For instance, consider a partygoer who may have heard that smoking cigarettes can be addictive and harmful but nonetheless begins to smoke anyway; this seems to be a less-informed decision than one made by a person with a parent whose smoking caused a specific and horrible illness (and associated expenses). Furthermore, the partygoer may be unduly influenced by peers or movies that glamorize smoking. So paternalistic regulations could be justified under some circumstances; *e.g.*, where risks are not adequately communicated or understood, for children, and so on.

Second, the assumption that a procedure to implant some human enhancement technology may affect the health and safety of *only* that patient appears to be much too generous. Indeed, it is rare to find any human activity that has absolutely no impact on other persons, either directly or indirectly, such that our own freedom or autonomy is the only value at stake and clearly should be protected. For instance, opponents to regulating such activities as gambling, recreational drugs (including smoking tobacco), prostitution, segregation, and so forth commonly cite the need to protect their freedom or rights as the primary objection to those regulations. Yet, this objection ignores the opposing argument, which is that such activities may harm *other persons*, either actually or statistically.

To look at just one of many examples, at first glance, unfettered gambling seems to affect only the gambler (it is his money to win or lose, so the argument goes); but a broader analysis would point out that many gamblers have families whose bank accounts are being risked and that desperate gamblers may commit crimes to finance their addiction, never mind harms to the out-of-control gambler himself. Even marijuana use, which in many cases may be justified and allegedly harms no one, might be traced back to dangerous cartels that terrorize or bully the local population. Furthermore, irresponsible use of the drug could cause accidents or the user to neglect his or her obligations, family, etc. Notice here that

we are not arguing that activities such as gambling and recreational drug use should be completely banned, but only that some measure of oversight seems to be appropriate for the sake of others, if not also for the welfare of the individual.

Relating back to the human enhancement debate, it seems premature to say that only the would-be enhanced person assumes any risk, even if the procedure does not affect his or her germline (*i.e.*, cannot be passed on to the next generation). The harm or risk to others could also be indirect: Where steroids use by athletes sets the presumably-wrong example for children whose bodies and minds are still developing, we can anticipate a similar temptation to be created with human enhancement technologies among children. Even parents may feel pressure—or even an obligation—to enhance their children, which arises from the natural desire to want the best for our children or, in this case, make them the best they can be (see question 21).

Third, even if the harm that arises from any given instance of human enhancement is so small as to be practically negligible, the individual choices to enhance oneself can lead to aggregate harms that are much larger and substantial. For instance, in today's environmental debate, calls are increasing to limit activities from lawn care or drinking bottled water: on one hand, the amount of extra water needed to keep one's lawn green seems small, as is also the amount of fertilizer or pesticide that might leach into the groundwater, but the cumulative effect of millions of homeowners caring for a pristine patch of grass can be disastrous for a nation's water supply and health.

Likewise, as human enhancement technologies improve and are adopted by more people, the once-negligible harms that arise from individual cases may metastasize into very real harms to large segments of society (Parfit, 1986). Life extension, as one case, may appear to be a great benefit for the individual, but on an aggregate scale, it could put pressure or burdens on families, retirement programs, overpopulation, and so on; we will return to this in question 13.

E. Fairness & Equity

11. Does human enhancement raise issues of fairness, access, and equity?

Even if we can understand why there would be pressure to enhance one's self or children, it is important to note the following: advantages gained by enhanced persons also imply a relative *disadvantage* for the unenhanced, whether in sports, employment opportunities, academic performance, or any other area. That is to say, fairness is another value to consider in the debate. A related worry is that the wealthy would be the first adopters of human enhancement technologies, given that they can best afford such innovations (like LASIK eye surgery), thus creating an even wider gap between the haves and the have-nots (McKibben, 2004).

In considering the issue of fairness, we need to be careful to not conflate it with equality. Under most economic theories, fairness does not require that we need to close the gap entirely between economic classes, even when justice is defined as fairness (Rawls, 1971; for an application of Rawls to enhancement, see Allhoff, 2005). Indeed, there are good reasons to think that we want some gap to exist, for example, to provide incentives for innovations, in order to move up the economic ladder, and to allow flexibility in a workforce to fill vacancies and perform a wide range of tasks. At least some competition seems to be desirable, especially when resources to be allocated are limited or scarce and when compared to the historically-unsuccessful alternative of the state attempting to equalize the welfare of its citizens.

Thus, inequality itself is not so much the point, though any poverty or decline in welfare related to increased inequality may be a serious concern. We do not want people to stop striving to improve their own lives, even if the situation for others is not improved at the same time or ever. And natural advantages and inequities already exist without moral issues anyway; Hobbes recognized that these organic differences did not give any individual or group of individuals so much *net* advantage that they would be invulnerable to the “nasty, brutish, and short” conditions that mark human life (Hobbes, 1651).

Yet if human enhancement technologies develop as predicted, they can afford us a tremendous advantage in life; *e.g.*, over others in a competition for resources, so much so that it overstretches the natural range of equality to the point where inequality becomes a more salient issue. This is where the gap between enhanced and unenhanced persons may be too wide to bridge, making the latter into dinosaurs in a hypercompetitive world. If we assume that the benefits of being an enhanced person must be largely paid from the welfare of others, *e.g.*, a job-gain by one person is a job-loss by another, since the others are now at a relative disadvantage, this may impoverish the unenhanced, which would limit their access to such things as healthcare, legal representation, political influence, and so on.

Related to the notion of equity is that of fairness. Even if pronounced inequality is morally permissible, there is still a question of *how* an individual accesses or affords a human enhancement technology, which may be unfair or unacceptably magnify the inequality. If the distribution of or access to enhancement technologies is not obviously unfair, *e.g.*, illegally discriminatory, then perhaps we can justify the resulting inequities. But what would count as a fair distribution of those technologies? A scheme based on need or productivity or any other single dimension would be easily defeated by the standard arguments that they overlook other relevant dimensions (Rescher, 1980). Even if a market system is considered to be fair or an acceptable approximation of it, many still object to the unfairness of our starting points, which may result from bad luck or

other arbitrary circumstances, or date back to monarchies, aristocracies, “robber barons”—recall the saying that behind every great fortune there is a great crime (de Balzac, 1835). And even if the starting points were fair, the subsequent market processes would need to be fair in order for the results (*e.g.*, that only the wealthy can afford human enhancement technologies, who then gain significant advantages over the unenhanced) to be declared fair (Nozick, 1974).

12. Will it matter if there is an “enhancement divide”?

We have heard much about the “digital divide”, but one day there may well be a “nano divide”: the gap between those who can access and benefit from nanotechnology and those without. If there is also an “enhancement divide”, it could prove to be an even greater disadvantage for those on the wrong side. They would not be as physically or mentally capable as others. What policies, if any, should be developed to either avoid or cope with this situation?

The rise of information and communications technology (ICT) led to the so-called “digital divide”: those who did not have adequate access to the technology were disadvantaged relative to those who did. While this divide reflected, by and large, the existing divide between haves and have-nots, ICT exaggerated that divide (Rooksby and Weckert, 2004). Not long ago, the less-advantaged within developed societies could listen to the radio, go to the free public library, and read inexpensive newspapers. As information and communication increasingly moved to the Internet, their access to both information and communication decreased relative to that by the more-advantaged. It is feared by some that nanotechnology will also sharpen and widen divisions both within societies and between nations: a nanodivide will be created. Whether or not this happens depends partly on how nanotechnology develops. If its applications are primarily in enhancing existing materials, cosmetics, electronics and medicine and if these are relatively inexpensive, then there may be no increase in inequalities. However, if they are expensive and particularly useful and desirable, then they probably will.

This in itself does not show that there is a problem, of course. There is a problem only if the created inequalities are unfair and therefore morally wrong. Technologies have both benefits and costs and inequities can occur in both. Just as benefits can be distributed unequally, so can the costs, but none of these inequalities is necessarily wrong, it can be argued. The argument that they do not matter morally can be derived from a number of ethical theories, but it also depends on the particular enhancements in question. Enhancements for a few that enable them to better solve the world’s environmental problems would satisfy Rawls’ difference principle in that the extra inequality in ability would help the worst off (Rawls, 1971). Enhancements in sporting ability or other abilities that

benefit only the person enhanced would fall foul of that principle and so perhaps should not be allowed. They might however, be justified on utilitarian grounds, if they help increase total happiness, or on the basis of desert or some other way. So the question “Will it matter if there is an enhancement divide?”, like many of the questions we explore in this report, cannot be easily answered but will involve an examination of the enhancements in question and of the underlying ethical theories.

F. Societal Disruptions

13. What kind of societal disruptions might arise from human enhancement?

Fairness and equality are not just theoretical values, but they have practical effects. Gross inequality itself, whether fair or not, can motivate the worse-off masses to revolt against a state or system. But societal disruption need not be so extreme to be taken seriously. Entire institutions today—as well as the lack thereof—are based on a specific range of abilities and rough equality of natural assets. Sports, for instance, would change dramatically, if enhanced persons are permitted to compete to the clear disadvantage of unenhanced athletes, smashing their previous records. (This is not to say that sports should ban enhanced competitors, only that doing so would have a real, significant affect on careers and expend valuable resources to adjust sporting programs and contests; and in the end, it is not clear that sports is better off for its trouble or that which it has caused.)

Other institutions and systems include economic (jobs), privacy, communications, pensions, security, and many other areas of society. For instance, if life-extension technologies can increase our average lifespan by 20 years—let alone the 100+ years predicted by some futurists (Kurzweil, 2005; de Grey, 2007), and assuming that the extra 20 years will be a good life, not one bogged down with illness and diminishing productivity that afflict many elderly today—then we would need to radically adjust retirement programs: do we move the retirement age to 85, which has negative consequences for job-seekers such as new tenure-track academic faculty, or increase contributions to pension plans, which puts pressure on household budgets and employers? Or both? Also, assuming birth rates do not decline (which causes problems of its own), longer lives will mean more pressure on resources such as energy and food, in addition to jobs, so this could disrupt society in negative ways.

Looking more into the distance, if enhancement technologies enable us to adapt our bodies to, say, underwater living (with implantable gills, flippers, echolocation, new skin, etc.), then we would need to construct new institutions to govern that lifestyle, from underwater real estate to pollution rules to law

enforcement to handling electronic devices to currency (replacing paper money of non-waterworlds). Or if this sounds too far-fetched, consider humanity's rush into outer space that will require similar attention to be paid to such issues in the near future (Lin, 2006).

Other nearer-term scenarios that may cause social disruption include: a job candidate with a neural implant that enables better data retention and faster information processing would consistently beat out unenhanced candidates; a person with super-human hearing or sight could circumvent existing privacy protections and expectations by easily and undetectably eavesdropping or spying on others; more students (and professors) using Ritalin may grab admission or tenure at all the best universities, reducing those opportunities for others; and so on.

14. Are societal disruptions reason enough to restrict human enhancement?

From the preceding answer, societal disruption is clearly a non-trivial concern and seems to be something we want to mitigate where we can, though this does not imply that we should resist change in general. Minimizing disruption might be achieved by transitioning laid-off workers immediately to a new job or job-training program, rather than allowing the layoffs to come unexpectedly which leaves the newly-unemployed with few options but to fend for themselves. Today, without this kind of preparation, we trust that these social and economic disruptions eventually will be handled, but there is still a real cost to those affected by layoff that could have been better mitigated. The typewriter industry, as an example, was blindsided by the fast-growing word-processing industry in the 1980s, leading to the displacement of thousands of workers, both on the manufacturing and the end-users' sides. (Similar situations exist for the spreadsheet industry that displaced countless accountants and bookkeepers, the computer-aided design industry that displaced graphic artists, and so on.)

But, unless it will be clearly and seriously harmful, social disruption by itself does not seem enough to count as a strong reason against regulating enhancement technologies. After all, we do not wish that typewriters were never replaced with word-processing programs, though we hope the affected employees readily found gainful jobs elsewhere. Human enhancement technologies, likewise, do not necessarily need to be halted or regulated, but it seems more prudent and responsible to anticipate and prepare for any disruptive effects.

To be clear, there presumably will be benefits to society from enhanced persons. We can expect greater productivity or more creative and intellectual breakthroughs, which is why individuals would want to be enhanced in the first place. But what remains difficult to calculate is whether these gains outweigh the

costs or risks, or even the likelihood of either gains or costs—which is needed if we do find it sensible to use a precautionary principle to guide our policymaking.

15. *If individuals are enhanced differently, will communication be more difficult or impossible?*

In *Philosophical Investigations*, Wittgenstein (1953) said that if a lion could speak, we could not understand it; and in *Alice's Adventures in Wonderland*, Lewis Carroll (1865) demonstrates some problems that Alice had communicating with a caterpillar. Both examples highlight the importance of the body in communication. For Wittgenstein sharing a language involves sharing a form of life, and lions and humans are too different to share the latter so they cannot share the former either. Language is social, and we communicate with each other about experiences that we have reason to believe we can all understand, more or less. This is a plausible belief given that we are the same species, made of the same stuff, close to the same shape, and with the same sense organs.

But what if we were radically different from each other? Suppose that some humans had the vision of an eagle or could see infrared. If some of us have enhanced vision or quite different vision, how would this affect communication and general social cohesion? Or consider a more radical situation in which someone is enhanced by the addition of a different sense; for example, the echolocation capabilities of a bat. Suppose too that it became possible to have enhancements of numerous kinds and that we could choose which we wanted, if any. Could a conservative, unenhanced human, communicate easily with highly-enhanced neighbors who had all kinds of experiences of which he could not conceive? Probably not. And communication may be even more difficult between people who have quite different enhancements.

The answer to the question is that almost certainly communication would become more difficult. Just how difficult is partly an empirical matter, of course. Sighted people can communicate with the sight-impaired. But given what we know about the social nature of language and the importance of shared experiences in communication, it is difficult to see how problems could be avoided. None of this may matter of course. We, as we currently are, are social creatures, but our enhanced heirs may not be, or not in the way that we are. They may not mind if there are few with whom they can easily communicate.

G. Human Dignity & The Good Life

16. Does the notion of human dignity suffer with human enhancements?

The fiercest resistance to human enhancement technologies is perhaps a concern about their effect on “human dignity” and what it means to be human (President’s Council on Bioethics, 2003; Sandel, 2007). For instance, does the desire for enhancement show ingratitude for what we have and (further) enable an attitude of unquenchable dissatisfaction with one’s life? Some researchers suggest that discontent is hardwired into the genetic makeup of humans (Hill, 2006; Woodall, 2007), which is why we constantly innovate, strive to achieve and gain more, etc. However, even if this is true, it does not seem to be so much an argument to promote human enhancement technologies, but more a worry that those technologies are not the panacea or Holy Grail of happiness we might believe them to be; that is, we will still be dissatisfied with ourselves no matter how much we enhance ourselves (unless, of course, we somehow eradicate that part of our DNA that causes discontent).

Would human enhancement technologies hinder moral development? Many believe that “soul-making” is impossible without struggle (Hick, 1966), and achievements ring hollow without sacrifice or effort (President’s Council on Bioethics, 2003); so if technology makes life and competitions easier, then we may lose opportunities to feed and grow our moral character. On the other hand, compare our lives today with pre-Internet days: increased connectivity to friends, work, information, etc. is often a double-edged proposition that also increases stress and decreases free time. This, then, raises the related concern of whether enhancement technologies will actually make our lives happier. (If the research mentioned above about discontent in our genes is accurate, then we might have a psychobiological reason to think not.)

Is the frailty of the human condition necessary to best appreciate life? There is something romantic about the notion of being mortal and fallible. But with existing pharmacology, we could eliminate the emotion of sadness today, and work is continuing on drugs that repress memories; but it is not clear that sadness (at least in the normal range, as opposed to clinical depression) is a “pathology” we should want to eliminate, rather than a human experience that we should preserve (President’s Council on Bioethics, 2003). Other critics have suggested that life could be too long, leading to boredom after one’s life-goals are achieved (*e.g.*, Williams, 1973).

Finally, we will mention here the related, persistent concern that we are playing God with world-changing technologies, which is presumably bad (Peters, 2007). But what exactly counts as “playing God”, and why is that morally wrong; *i.e.*, where exactly is the proscription in religious scripture? If we define the

concept as manipulating nature, then we all have been guilty of that since the first man picked up a stick. Making life-and-death decisions is a plausible candidate as a definition, but then physicians as well as soldiers (even in holy wars?) could be accused of this charge.

17. Will we need to rethink the notion of a “good life”?

Up until now, we have had a reasonably good idea of what makes life better, and we can be fairly confident about what makes life better for most, and, although this is more controversial, roughly what constitutes a good life. For Aristotle, the one thing that everyone wanted for its own sake was happiness, and the best way of achieving this was through a life of contemplation, or study (Aristotle, 1941 trans.). Happiness (or *eudaimonia*) for Aristotle was a much richer concept than it currently is for us. It involved living well and doing well, it was something that lasted for a sustained period (one could not be happy for just an hour), and it could not apply to just one aspect of life. In general, it meant overall success, prosperity, and achievement. It resulted from virtue, but also required external goods, for example good birth, good children and beauty.

James Moor argues that there are certain underlying core values that all people have (Moor, 1999). These are: life, happiness (pleasure), and autonomy. In order to exercise our autonomy we require the *ability* to do various things, the *security* to do them, the *knowledge* about doing them, the *freedom* and *opportunity* to do them, and finally the *resources* to accomplish our goals. In order to achieve a good life we require all of these, but different people will not give all of the components the same weightings, and therefore conceptions of the good life will be different for different people, but not radically so. Aristotle and Moor both are talking about humans as they are now.

In the future, with human enhancements, things will be less clear. Do we know if particular “enhancements” will improve life? Will enhanced people be happier, and if not, why bother with enhancements? Can we say much about the “good life” for an “enhanced” person? One important factor is this: Currently, people around the world are more or less the same. We know in general what sorts of things make people happy, what makes them suffer, what gives pleasure and pain, and so on. If human enhancements become widespread, it is likely that people will become very different from each other. Many different kinds of enhancements, and enhancements to different levels may be possible, and if people are free to choose, they will choose differently. So it may not be known what should be done to relieve the suffering or increase the pleasure of others. In an important respect, our commonality will be lost, and if this is so, the notion of “the good life” becomes vacuous in the sense of being even a vague guide for action.

It is difficult to know whether enhancement would make life better overall. Consider direct communication between brains: How would this affect our privacy? Currently, my thoughts are mine alone, more or less, something for which I am very grateful. This is not so much because I intentionally think things that I should not, but more that I do not have the same sort of control over my thoughts that I have over my actions. My autonomy would be reduced to the extent that I would have much less control over what people knew about me, and this would certainly make me more vulnerable to government and employer control. Consider too enhanced senses: Suppose that I had the vision of an eagle. I really cannot say that this would improve my life, because I have no idea what it would be like.

Humans are basically social creatures who like living in groups, and this aspect would appear to be under threat in a diversely enhanced world. Could one be a friend of a much more enhanced person? Aristotle would probably say not. Real friends must be equals. Could I understand this person? Wittgenstein would have his doubts. While both Aristotle and Wittgenstein might both appear to overstate the case, communication and friendship are easier between people who are similar, and radical enhancements raise the possibility of very diverse groups of humans (or creatures like humans) existing. Such considerations do suggest that there would be a need to rethink what constitutes a good life, or even an improved life, for humans.

H. Rights & Obligations

18. Is there a right to be enhanced

Rights can be divided into two broad classes: a class of human rights, sometimes called “natural rights”, and a class of more conventional rights based on the specific customs, roles, and laws of a society. Examples of the former are famously listed in the American Declaration of Independence: “We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness.” The right to enhancement is not included in this list or in other familiar lists of human rights. But it could be argued that a right of enhancement is a right derived from some or all of the human rights like those listed in the Declaration of Independence. Humans should be able to exercise their right to enhancements to the extent that it promotes their life, liberty, or the pursuit of happiness.

However, this at most would make a right to enhancement a *prima facie* right because human rights themselves, though fundamental, can conflict and are susceptible to modification and qualification. One’s right to liberty, for example,

does not automatically permit infringement on the rights of others. Rights frequently trump in our considerations about which action is correct. But rights can also be trumped by other rights or by extremely harmful consequences. Therefore, even if the right to enhancement is regarded as a derived human right, its application in a particular situation could be challenged on the grounds that it infringes on the rights of others or that its exercise would lead to extreme harm.

The right to enhancement can also be regarded as conventional. “Conventional” does not mean “arbitrary” but “established by general agreement or practice.” We can make laws, for example, that allow some enhancements and laws that prohibit others. How justified such conventional rights or prohibitions are depends upon how good the reasons for them are. We might easily justify the use of nanodevices that patrol our bodies for cancerous outbreaks. We would prohibit the use of nanodevices that would give humans a burst of intelligence followed by likely seizures and strokes.

Discussion of rights remains controversial in philosophical circles. Some argue that the justification of human enhancement in particular could be better carried out in terms of fundamental values such as life, health, knowledge and sociability (Hopkins, 2008). But arguments based on rights and arguments based on human values tend to emphasize common notions of human dignity and the good life.

19. Could human enhancement give us greater or fewer rights?

Future enhancements could either increase or decrease our rights. Today, this is played out in the world of sports where the enhancements may come through the use of drugs. Those in charge of a sport must set the rules to allow or forbid enhancements. In swimming, some aquadynamic swimsuits are allowed and some are not. Now suppose nanodevices of the future alter our bodies when we are in the water to make us more aquadynamic. Should such enhanced swimmers be allowed to compete against unenhanced swimmers? In situations like this, judgments about rights that take into account fairness have to be made. The nanoenhanced swimmers could be prohibited from competing at all or they could be given a new right to compete within a new class of swimmers or, if the nanoenhancement is easily obtainable by all competitors, the right to use it could be extended to everyone. Consider the case of Oscar Pistorius, the South African sprinter who had his legs amputated when he was a year old but now runs on artificial legs (Edwards, 2008a). He missed the qualifying time for the 2008 Summer Olympics by just three-quarters of a second. Some argue that his new legs, which give considerable spring to his run and do not require blood circulation, have given him an enhancement that should not be allowed in races with normal runners. Others argue that he should not lose the right to compete

with non-disabled runners. The boundaries of our rights will continue to shift as further enhancements are developed.

Beyond sports we might imagine what rights and duties would be affected if future enhancements give some individuals in society much greater physical and mental abilities than they have now: Should they have greater rights or liberties than unenhanced persons? Would the enhanced then have some duty to care for the unenhanced, just as the better-informed and capable parent has a duty to care for her child? Human enhancement may create a wide moral chasm between the haves and have-nots. In such a case, resolving issues of rights and responsibilities will take on considerable importance to avoid significant social and economic disruptive effects

20. Is there an obligation in some circumstance to be enhanced?

In some circumstances, there may be an obligation or at least a strong argument to enhance. Assuming vaccinations are enhancements, we have an obvious example of a case in which enhancements are required or at least strongly recommended. We require pilots to have training and pass stringent tests, necessary for the enhancements of a prospective pilot's capabilities for everyone's safety. Today, prisoners wear ankle bracelets that transmit information about their location. This is a kind of enhancement we allow, given prisoners have forfeited some of their rights; moreover, there is a strong argument for doing this because it relieves overpopulation in prisons while guarding against possible flight risk by a nonviolent offender.

One area in which we can expect required enhancements to increase is the military. In the military, soldiers have fewer rights than civilians; they lose freedoms and have to obey reasonable orders. Of course, that is the issue: Is it reasonable for the military to require enhancement of soldiers beyond their usual training? One likely possibility is the use of nanochip "dog tags" that will allow soldiers to be identified in case of death. Such chips could also be locators for supervising officers to track them—how useful on the battlefield to know where all of your soldiers are and know the state of their health. Naturally, weapons and equipment will also be enhanced. Today, there are prototypes of devices that make soldiers almost invisible by projecting the scene behind them in front of them. But there is no reason to stop there. Why not implant devices so that soldiers can be ordered to do what you want either through oral and written commands or through direct connections to the decision and motor operations of their brains? At some point, such enhancements have crossed the line of which enhancements should be allowed, let alone required. Nevertheless, the need for quick, effective, and decisive actions by the military will put significant pressure toward producing a super soldier.

21. *Should children be enhanced?*

Whether children should be enhanced is a particularly difficult issue. We give adults considerable freedom to do what they wish to themselves, as long as it does not harm others. But children are children. Parents must face the issue of parental rights and responsibilities associated with decisions to enhance children, whether directly (after the child is born) or indirectly through germ-line enhancements (to the parent's transmittable genes, prior to the child's birth) (Allhoff, 2005). This generates quandaries about selecting the proper actions that will only be exacerbated by future enhancement possibilities through nanotechnology. On the one hand, if parents enhance children with nanotechnology, they will be making crucial decisions about the capabilities of their children that may be irreversible and limit their children's future choices and opportunities. Will the child agree with the choices when he or she is older? On the other hand, parents already make similar choices in many areas on behalf of their children—*e.g.*, quality of school/education, a proper diet, moral guidance, etc.—will enhancements overstep any bounds in that effort? Prevailing wisdom suggests that parents do not have an unlimited right to raise their children however they want; that right, if one exists, seems to be limited by health and safety concerns related to the child.

Some have argued at least with regard to education that children possess a further right beyond health and safety. Article 26 of the United Nations Universal Declaration of Human Rights states that everyone has the right to education and that education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. These rights in turn suggest duties for parents and for society. If education is a kind of social enhancement, this lays the groundwork for claiming that other kinds of enhancements might be the right of children and correlative duties of parents and children. Will, for example, children of the future be expected to receive enhancements of their bodies that lead to “the full development of human personality”? Exactly what might be required will depend on the facts of the situation, of course. As we have said, context matters. But what this account shows is that there is at least a possible line of argument that supports not only the right of children to be enhanced but also a duty of their parents or society to do it.

Another difficulty raised with enhancing children turns on the therapy-enhancement distinction that we discussed in question 4. Therapy is often required on a child's behalf, whereas enhancement may be more voluntary. In the deaf community, an ongoing debate occurs about whether treating deafness is therapy or enhancement. Some in the deaf community maintain that being deaf is not something that needs treating. The deaf community functions with its own

language and community. This would be undermined if deafness were removed. This leads some to argue that deaf children do not require therapy and there is no decisive reason why deaf children should receive enhancement such as a cochlear implant. Indeed, real-world cases exist in which, *e.g.*, deaf parents have been permitted to deliberately select embryos for *in vitro* fertilization that would lead to deaf babies. Others believe that deafness requires therapy. On this latter view there is much more pressure put on parents of a deaf child to perform their duty of care toward health and safety and install a cochlear implant for therapeutic reasons.

Another common concern about enhancing children lies in the possibility that parents will enhance their children to give them an edge in society. Rather than simply buying them new laptops for school, in the future parents might buy nanochips for their children's bodies. The size of our working memory has much to do with our intelligence. Suppose some nanochips could be added to instantly give children a larger working memory; what an advantage they would have over other children without them. Of course, it is not only cognitive enhancement but also the enhancement of beauty and functionality of other parts of the body that might be possible. Beauty queens and track stars could be made, improving the outcomes of the genetic lottery. The likely result of such an enhancement race by parents will strike many as an unhealthy and unsound approach to developing the potential children—but how do we prevent it?

I. Policy & Law

22. What are the policy implications of human enhancement?

Given the preceding discussion, it should be clear that human enhancement is more than just about the individual's freedom or autonomy: there are plausibly negative consequences on others and society that need to be considered. Or at least an argument needs to be made that freedom/autonomy trumps all other values, but such a position seems unnecessarily dogmatic. These issues point to the policy dilemma of whether we should have regulations or restrictions on human enhancement technologies, so to prevent or mitigate some of the negative impacts considered. Three answers suggest themselves: (1) no restrictions, (2) some restrictions, or (3) a moratorium or full ban.

A moratorium seems unrealistic to the extent that a worldwide one would be needed to truly stem the use of human enhancement technologies, and that no worldwide moratorium on anything has yet been shown to work, including on (alleged) attempts to clone a human being. A local moratorium would send patients to “back-alley” enhancement clinics or to more liberal regions of the world, as is the case with “cosmetic-surgery vacations” to countries in which

those medical procedures are less expensive in other nations. Further, a ban on enhancement research seems much too premature—an overreaction to perceived, future risks—as well as a real threat to therapy-related research today.

On the other side of the spectrum, the idea of having no restrictions on human enhancement technologies seems to be reckless or at least unjustifiably optimistic, given that there are plausible risks. As pointed out earlier, complete freedom or autonomy may be a recipe for disaster and chaos in any case; we do not want to grant the right to yell “Fire!” in a crowded venue or the right of dangerous felons to own firearms.³

So what about finding middle ground with some non-Draconian regulations? Critics have argued that any regulation would be imperfect and likely ineffectual, much like laws against contraband or prostitution (Naam, 2005); but it is not clear that eliminating these laws would improve the situation, all things considered. Also, as a society, we still believe we ought to at least try to solve social ills, even if we cannot ultimately fix the entire problem, *e.g.*, we cannot stop any given crime from ever occurring again, yet we still have laws against such acts. And even if there are practical reasons not to pursue regulation, would that send the wrong message; *e.g.*, to children, that we support enhancement without reservations?

The issue of regulation will surely not be settled here, nor do we intend it to. Yet it is important to keep in mind that the human enhancement debate is not just a theoretical discussion about ethics, but it has bearing on the real world with policy decisions that may affect not just the would-be enhanced, but also researchers, manufacturers, social institutions, as well as our ideals of freedom and human dignity (Lin, 2007).

23. Should there be limits on enhancements, e.g., for military purposes?

At this stage, without knowing exactly what kinds of human-enhancing devices and treatments will be invented, the answer is unclear. As we discussed previously, there may be a compelling case to limit those enhancements that pose serious health risks to the individual or profoundly upset social institutions, at least until we are able to evolve those institutions—such as sports or college admissions—to account for an enhancement divide.

Gratuitous enhancements seem to be an easy case. To the extent that they are not harmful to the individual, *e.g.*, an ordinary tattoo, and are not public nuisances, *e.g.*, a profane and visible tattoo that offends the sensibilities of others, there does not seem to be a compelling reason to limit them, apart from some argument that they desecrate the body and impinge upon human dignity. Un-

³ Perhaps even the right to be happy may be inappropriately exercised, say, at a funeral?

enhancements (see question 8 above) pose a more difficult case study in that we must balance the interest and expressed will of the individual against what most persons would consider to be deliberate and serious harm to one's self.

Military applications of human enhancement technologies presents an even trickier moral and social dilemma: should we be in the business of *weaponizing* or modifying humans for someone else's ends, specifically to inflict harm on others or otherwise better prosecute a war (American Association for the Advancement of Science, 2006)? We will also not fully address such a complicated issue here, except to note that it involves considerations related to arms proliferation (*e.g.*, does this encourage other nations to invest in similar research?), national priorities (*e.g.*, might research funding be better spent elsewhere, given that any advantage we gain may be temporary until our enemies replicate our technologies, as they historically do?), asymmetrical warfare (*e.g.*, if enemies are more easily defeated by our super-soldiers, will they adapt by taking more desperate measures, such as more aggressively pursuing nuclear or biochemical weapons?), and other issues familiar to ethics and warfare.

24. *Might enhanced humans count as someone's intellectual property?*

Generally speaking, naturally-occurring objects (*e.g.*, air, water, other raw materials) cannot be patented, and human beings cannot be legally owned; so whether one could patent or otherwise claim intellectual property (IP) rights over an enhanced human seems to be a moot question. However, there might be more to this issue, once we recognize the related debate on biotechnology patenting, specifically as it relates to genomics. (Engineered biomedical devices, such as an artificial heart or knee, would clearly be patent-eligible under existing US law, though we will return shortly to the question of whether they ought to be.)

In the US, the biotechnology-patenting debate starts with the landmark legal decision *Diamond v. Chakrabarty*, in which the Supreme Court (by a narrow 5-4 margin) ruled that a genetically-modified, oil-eating bacterium—which is not naturally occurring—is patent-eligible (US Supreme Court, 1980). Since then, the courts have also established that parts or sequences of genes, though not the entire gene itself, may be patented if its function is also articulated (*e.g.*, US Court of Appeals for the Federal Circuit, 2009). Thus, it is possible that some sequence of a gene may be discovered, isolated, and functionalized in a human-enhancing application, *e.g.*, to slow or halt aging or give us superhuman strength or vision. If that happens, then the usual consequences of patent protection would likely occur, *i.e.*, the cost of such a procedure or drug would be high, at least for the first 20 years, given a lack of direct competitors.

This particular consequence strikes at the core of the access concern, as discussed previously: Whether through genomics, robotics, or other technologies,

the ability to acquire enhanced abilities will turn on the individual's ability to pay. Putting aside the issue of whether we have a *right* to enhance ourselves and how that is impacted by the high cost of such devices and treatments, it may be reasonably expected that IP law would create an "enhancement divide" between the enhanced (those who can afford it) and unenhanced (those who cannot afford to pay), which is cause for concern.

Furthermore, again setting rights aside, it will undoubtedly be argued that some human-enhancing treatments ought to belong to all of humanity and not be protected by IP law. For instance, it would seem immoral to withhold or otherwise raise barriers (such as to charge a price that some are unable to pay) to receive some therapy that can cure cancer or aging, just as it is to deny access to basic materials needed for our survival, *e.g.*, food and water. Such IP may represent essential discoveries needed to move science ahead: for instance, in nanotechnology, there are already criticisms that patents are a hindrance to basic science (Bawa, 2004). As an analogy, imagine how stunted science would be if the first microscope had been patented and its use restricted to only those who could afford to pay a licensing fee, or how radically different our world today would be if merely accessing the Internet required a similar use-fee (on top of any service provider fees). Further, it can be—and has been—claimed that *all* IP rights are harmful to innovation and indeed contradict the basic principles of a free-market economy, since they are essentially legalized monopolies (Boldrin and Levine, 2008; Torrance and Tomlinson, 2009). Without the protection of patents and copyrights, companies would be forced to compete on price, quality, customer service, and so on, which is a competition that seems to be good for broader public. Open-source computing is an example of such a business model.

Of course, the opposing side will rely on the standard argument that IP rights are a necessary form of incentive for innovation: without IP protection, companies and individuals would be much less likely to risk investing time and research funds to develop products that can simply be copied by competitors (Lessig, 2002). We will not engage this larger debate on whether or not IP law promotes social goods, except to reiterate that it has a bearing on the issue of fairness and access to human enhancement technologies.

25. Will we need to rethink ethics itself?⁴

To a large extent, our ethics depends on the kinds of creatures that we are. Philosophers traditionally have based ethical theories on assumptions about human nature. With enhancements we may become relevantly different creatures

⁴ This section builds upon previous work: James H. Moor, "Why We Need Better Ethics for Emerging Technologies", *Ethics and Information Technology* (2005) 7: 111-119.

and therefore need to rethink our basic ethical positions. For example, will we be as sympathetic toward other humans that differ substantially from us in their nature? We may need to do ethics differently. Converging technologies—for example, nanotechnology, neurotechnology, genetics and information technology—will almost certainly enable some dramatic enhancements, at least in the medium term.

The emergence of these potentially powerful technologies raises the question of what our technological future will be like. Will the quality of our lives improve with increased technology or not? We at least collectively can affect our futures by choosing which technologies to have and which not to have and by choosing how technologies that we pursue will be used. The question really is: How well will we choose? The emergence of a wide variety of new technologies should give us a sense of urgency in thinking about how we approach these technologies and enhancements ethically. Which kinds should we develop and keep? And, how should we utilize those that we do keep? It is not satisfactory to do ethics as usual. Better ethical thinking in terms of being better informed and better ethical action in terms of being more proactive are required.

Technologies, particularly new converging technologies for human enhancement, generate many ethical problems. Sometimes the problems can be treated easily under existing ethical policies. But because new technology allows us to perform activities in new ways, situations may arise in which we do not have adequate policies in place to guide us. We are confronted with *policy vacuums*. We need to formulate and justify new policies (laws, rules, and customs) for acting in these new kinds of situations. Sometimes we can anticipate that the use of the technology will have consequences that are clearly undesirable. As much as possible, we need to anticipate these and establish policies that will minimize the deleterious effects of the new technology. At other times the subtleties of the situation may escape us, at least initially, and we will find ourselves in a situation of assessing the matter as consequences unfold. Formulating and justifying new policies is complicated by the fact that the concepts that we bring to a policy-vacuum situation may not provide a unique understanding of the situation: the situation may have analogies with different and competing traditional situations. We find ourselves in a *conceptual muddle* about which way to understand the matter in order to formulate and justify a policy.

To avoid such a quandary, first, we need realistically to take into account that ethics is an ongoing and dynamic enterprise. Second, we can improve ethics by establishing better collaborations among ethicists, scientists, social scientists, and technologists. We need a multi-disciplinary approach (Brey, 2000). The third improvement for ethics would be to develop more sophisticated ethical analyses. Ethical theories themselves are often simplistic and do not give much guidance to particular situations. Often the alternative is to do technological

assessment in terms of cost/benefit analysis. This approach too easily invites evaluation in terms of money while ignoring or discounting moral values which are difficult to represent or translate into monetary terms. At the very least, we need to be more proactive and less reactive in doing ethics (Moor and Weckert, 2004).

J. Conclusion

In the above, we offer a preliminary survey of many of the major questions in the ethics debate on human enhancement. A full discussion is beyond the scope of this investigation and, indeed, could take an entire book to satisfactorily answer each question. But our brief introduction here is valuable as an entry point to the human enhancement ethics controversy, which is quickly gaining momentum and complexity.

An impressive array of technologies is driving the urgency of this debate, from familiar drugs (*e.g.*, steroids, modafinil, Ritalin) to fantastic visions of a cybernetic future. No one knows which visions—utopian, dystopian, or pedestrian—ultimately will be realized. But insofar as there are good reasons to think that many of these visions are plausible, it seems prudent to at least begin a conversation about the many ethical and social issues associated with human enhancement, especially since ethics seem to historically lag (far) behind technology and other quickly-evolving events. By planning ahead, we can be better prepared to enact legislation or regulation as deemed fit.

In our discussions, we have striven to follow a disinterested, sensible middle path in presenting the various sides of each issue, given the early stage of this debate, though clearly there are passionate and opposing forces engaged in this international struggle for clarity and policy. An increasing flow of thoughtful literature exists as we write this (*e.g.*, Savulescu and Bostrom, 2009), and we expect the arguments to continue for many more years—proving the prediction that human enhancement ethics will be the most important debate in science and society in this brave new century. Because human enhancement is such a personal matter, for the moment, we leave it to our readers to use their own moral compass to navigate these myriad camps and find their own path to ethical answers.

K. References

- Allhoff, F., 2005. "Germ-Line Genetic Enhancement and Rawlsian Primary Goods", *Kennedy Institute of Ethics Journal* 15.1: 39-56.
- Allhoff, F., Lin, P., Moor, J., and Weckert, J., 2007. *Nanoethics: The Social and Ethical Dimensions of Nanotechnology*. Hoboken, NJ: John Wiley & Sons.
- Allhoff, F., Lin, P., and Moore, D., forthcoming. *What is Nanotechnology and Why Does It Matter?: From Science to Ethics*. Hoboken, NJ: Wiley-Blackwell Publishing.
- Allhoff, F. and Lin, P., 2008. *Nanotechnology & Society: Current and Emerging Issues*. Dordrecht: Springer.
- American Association for the Advancement of Science, 2006. *Good, Better, Best: The Human Quest for Enhancement*. Washington, DC: AAAS.
- Aristotle, 1941. *Nicomachean Ethics*, in *The Basic Works of Aristotle*, ed. R. McKoen, pp. 927-1112. New York: Random House.
- Bailey, R., 2005. *Liberation Biology: The Scientific and Moral Case for the Biotech Revolution*. Amherst, NY: Prometheus Books.
- Bawa, R., 2004. "Nanotechnology Patenting in the US", *Nanotechnology Law & Business* 1.1: 31-50.
- Boldrin, M. and Levine, D., 2008. *Against Intellectual Monopoly*. New York: Cambridge University Press.
- Bostrom, N. and Roache, R., 2008. "Ethical Issues in Human Enhancement" in *New Waves in Applied Ethics*, eds. Ryberg, J., Petersen, T.S., and Wolf, C. New York: Palgrave Macmillan.
- Brey, P., 2000. "Method in Computer Ethics: Towards a Multi-Level Interdisciplinary Approach", *Ethics and Information Technology* 2.2: 125-129.
- Buyx, A., 2007. "Be Careful What You Wish For? Theoretical and Ethical Aspects of Wish-Fulfilling Medicine", *Medicine, Health Care, and Philosophy* 11.2: 133-143.
- Camus, A., 1951. *The Rebel: An Essay on Man in Revolt* (Vintage International edition, 1982), New York: Vintage International.

- Carroll, L., 1865. *Alice's Adventures in Wonderland* (Penguin Classics edition, 1994). London: Penguin Classics.
- Daniels, N., 2000. "Normal Functioning and the Treatment-Enhancement Distinction", *Cambridge Quarterly of Healthcare Ethics* 9: 309-322.
- de Balzac, H., 1835. *Père Goriot* (Signet Classics edition, 2004), trans. Henry Reed. New York: Signet Classics.
- de Grey, A., 2007. *Ending Aging: The Rejuvenation Breakthroughs that Could Reverse Human Aging in Our Lifetime*. New York: St. Martin's Press.
- Dennis, C., 2004. "Genetics: Deaf by Design", *Nature* 431: 894-896.
- Dyer, C., 2000. "Surgeon Amputated Healthy Legs", *British Medical Journal* 320: 332.
- Edwards, S.D., 2008a. "Should Oscar Pistorius be Excluded from the 2008 Olympic Games?", *Sports, Ethics, and Philosophy* 2: 112-125.
- Edwards, S.D., 2008b. "The Ashley Treatment: A Step Too Far, or Not Far Enough?", *Journal of Medical Ethics* 34: 341-343.
- Freitas Jr., R.A., 1998. "Exploratory Design in Medical Nanotechnology: A Mechanical Artificial Red Cell," *Artificial Cells, Blood Substitutes, and Immobilization Biotechnology* 26: 411-430.
- Friends of the Earth, 2006. *The Disruptive Social Impacts of Nanotechnology: Issue Summary*. Last access on 1 August 2009: <http://nano.foe.org.au/node/151>.
- Fukuyama, F., 2002. *Our Posthuman Future: Consequences of the Biotechnology Revolution*. New York: Picador.
- Fukuyama, F., 2006. *Beyond Bioethics: A Proposal for Modernizing the Regulation of Human Biotechnologies*. Washington DC: School of Advanced International Studies, Johns Hopkins University.
- Greely, H., 2005. "Regulating Human Biological Enhancements: Questionable Justifications and International Complications", *The Mind, The Body, and the Law: University of Technology, Sydney, Law Review* 7: 87-110 (2005) / Santa Clara Journal of International Law 4: 87-110 (2006) (joint issue).

Guston, D., Parsi, J., and Tosi, J., 2007. "Anticipating the Ethical and Political Challenges of Human Nanotechnologies" in Allhoff et al., 2007.

Harris, J., 2007. *Enhancing Evolution: The Ethical Case for Making Ethical People*. Princeton: Princeton University Press.

Hick, J., 1966. *Evil and the God of Love*. New York: Harper and Row Publishers.

Hill, S.E., 2006. *Dissatisfied by Design: The Evolution of Discontent* (dissertation). Austin: University of Texas.

Hobbes, T., 1651. *Leviathan* (Penguin Classics edition, 1982). New York: Penguin Group.

Hopkins, P., 2008. "Is Enhancement Worthy of Being a Right?", *Journal of Evolution and Technology*, 18: 1-9.

Hughes, J., 2004. *Citizen Cyborg: Why Democratic Societies Must Respond to the Redesigned Human of the Future*. Cambridge, MA: Westview Press.

Hurlbut, W., 2006. Opening remarks at "Human Enhancement Technologies and Human Rights" conference, Stanford University Law School, 26-28 May 2006.

Juengst, E., 1997. "Can Enhancement Be Distinguished from Prevention in Genetic Medicine?", *Journal of Medicine and Philosophy* 22: 125-142.

Kurzweil, R. 2005. *The Singularity is Near: When Humans Transcend Biology*. New York: Viking Penguin.

Lessig, L., 2002. *The Future of Ideas: The Fate of the Commons in a Connected World*. New York: Random House.

Lin, P., 2006. "Space Ethics: Look Before Taking Another Leap for Mankind", *Astropolitics* 4: 281-294.

Lin, P., 2007. "Nanotechnology Bound: Evaluating the Case for More Regulation", *NanoEthics: Ethics for Technologies that Converge on the Nanoscale* 2: 105-122.

Lin, P. and Allhoff, F., 2007. "Nanoscience and Nanoethics: Defining the Discipline" in Allhoff et al. 2007.

- Lin, P. and Allhoff, F., 2008. "Introduction: Nanotechnology, Society, and Ethics" in Allhoff et al., 2008.
- Lin, P. and Allhoff, F., 2008b. "Untangling the Debate: The Ethics of Human Enhancement", *NanoEthics: Ethics for Technologies that Converge at the Nanoscale 2*: 251-264.
- McKibben, B., 2004. *Enough: Staying Human in an Engineered Age*. New York: Henry Holt & Co.
- Mielke, J., 2008. "Digital Tattoo Interface" entry at Greener Gadgets Design Competition 2008, New York, NY, February 2008. Last accessed on 1 August 2009: <http://www.core77.com/competitions/GreenerGadgets/projects/4673/>.
- MIT, 2008. Institute for Soldier Nanotechnologies website. Last accessed on 1 August 2009: <http://web.mit.edu/ISN/research/index.html>.
- Moor, J., 1999. "Just Consequentialism and Computing", *Ethics and Information Technology 1*: 65-69.
- Moor, J. and Weckert, J., 2004. "Nanoethics: Assessing the Nanoscale from an Ethical Point of View" in *Discovering the Nanoscale*, eds. D. Baird, A. Nordmann and J. Schummer, pp. 301-310. Amsterdam: IOS Press.
- Moor, J., 2005. "Why we need better ethics for emerging technologies", *Ethics and Information Technology 7*: 111-119.
- Naam, R., 2005. *More Than Human*. New York: Broadway Books.
- Nozick, R., 1974. *Anarchy, State, and Utopia*. New York: Basic Books.
- Parfit, D., 1986. *Reasons and Persons*. New York: Oxford University Press.
- Parviz, B.A., et al., 2008. "Contact Lens with Integrated Inorganic Semiconductor Devices", presentation at 21st IEEE International Conference on Micro Electro Mechanical Systems, Tuscon, AZ, 13-17 January 2008.
- Persaud, R., 2006. "Does Smarter Mean Happier?" in *Better Humans?: The Politics of Human Enhancement and Life Extension*, eds. J. Wilsdon and P. Miller. London: Demos.
- Peters, T., 2007. "Are We Playing God with Nanoenhancement?" in Allhoff et al. (2007).

President's Council on Bioethics, 2003. *Beyond Therapy: Biotechnology and the Pursuit of Happiness*. Washington, DC: Government Printing Office.

Rawls, J., 1971. *A Theory of Justice*. Cambridge, MA: Belknap Press.

Rescher, N., 1980. "The Canons of Distributive Justice" in *Justice: Alternative Political Perspectives*, ed. Sterba, J. Belmont: Wadsworth Publishing Co.

Roco, M. and Bainbridge, W.S., 2003. *Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive Science*. Dordrecht: Kluwer Academic Publishers.

Rooksby, E., and Weckert, J., 2004. "Digital Divides: Their Social and Ethical Implications" in *Social, Ethical and Policy Implications of Information Technology*, eds. L. Brennan & V. Johnson, pp. 29-47. Hershey, PA: IGI.

Saletan, W., 2008. "Night of the Living Meds: The US Military's Sleep-Reduction Program", *Slate*, 16 July 2008. Last accessed on 1 August 2009: <http://www.slate.com/id/2195466/>.

Sandel, M., 2007. *The Case Against Perfection: Ethics in the Age of Genetic Engineering*. Cambridge, MA: Belknap Press.

Savulescu, J. and Bostrom, N., 2009. *Human Enhancement*. New York: Oxford University Press.

Savulescu, J., and Foddy, B., 2007. "Ethics of Performance Enhancement in Sport: Drugs and Gene Doping", in *Principles of Health Care Ethics*, eds. Ashcroft, R.E., Dawson, A., Draper, H., and McMillan, J. R. London: John Wiley & Sons.

Scott, Kristi, 2009. "Cheating Darwin: The Genetic and Ethical Implications of Vanity and Cosmetic Plastic Surgery", *Journal of Evolution and Technology* 20.2: 1-8. Last accessed on 1 August 2009: <http://jetpress.org/v20/scott.htm>.

Selgelid, M., 2007. "An Argument Against Arguments for Enhancement", *Studies in Ethics, Law, and Technology* 1: Article 12. Last accessed on 1 August 2009: <http://www.bepress.com/selt/vol1/iss1/art12/>.

Thompson, M., 2008. "America's Medicated Army", *Time*, 16 June 2008. Last accessed on 1 August 2009: <http://www.time.com/time/nation/article/0,8599,1811858,00.html>

Thompson, P., 2008. "The Opposite of Human Enhancement: Nanotechnology and the Blind Chicken Problem" in Human Enhancement & Nanotechnology symposium, eds. Allhoff, F. and Lin, P., *NanoEthics: Ethics for Technologies that Converge at the Nanoscale 2*: 305-316.

Torrance, A. and Tomlinson, B., 2009. "Patents and the Regress of Useful Arts", *Columbia Science and Technology Law Review* 10: 130-168.

US Court of Appeals for the Federal Circuit, 2009. *In re Kubin*, Fed. Cir., No. 2008-1184. Last accessed on 1 August 2009:
<http://www.cafc.uscourts.gov/opinions/08-1184.pdf>.

US Supreme Court, 1980. *Diamond v. Chakrabarty*, 447 U.S. 330

Williams, B., 1973. *Problems of the Self*. Cambridge, UK: Cambridge University Press.

Wittgenstein, L., 1953. *Philosophical Investigations* (Blackwell edition, 1972), trans. G.E.M. Anscombe. Oxford: Blackwell.

Woodall, J., 2007. "Programmed Dissatisfaction: Does One Gene Drive All Progress in Science and the Arts?", *The Scientist*, vol. 21, issue 6: 63.