

# Enhancement Technologies and the Body

Linda F. Hogle

Department of Medical History and Bioethics and Department of Anthropology,  
University of Wisconsin, Madison, Wisconsin 53706; email: lfhogle@wisc.edu

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## Key Words

medical anthropology, bioethics, technology

## Abstract

The technological ability to alter biology, along with the social conditions and cultural expectations that enable such transformations, is spawning a variety of techniques that augment bodily forms and functions. These techniques, collectively known as enhancement technologies, aim to improve human characteristics, including appearance and mental or physical functioning, often beyond what is ‘normal’ or necessary for life and well-being. Humans have always modified their bodies. What distinguishes these techniques is that bodies and selves become the objects of improvement work, unlike previous efforts in modernity to achieve progress through social and political institutions. There are profound effects on sociality and subjectivity. This chapter reviews analytical approaches through which researchers have attempted to illuminate the practices, moral and economic reasoning, cultural assumptions and institutional contexts constituting enhancements, framing the discussion by examining the concept of the normal body. Examples from cosmetic, neurological and genetic enhancements will illustrate.

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## INTRODUCTION

Some scholars suggest bodies as they now exist are an arbitrary, evolutionary solution to issues of mobility, communication, and functioning in the environment (Hockenberry 2001). If this is true, the solution we have may not be the best one—bodies are imperfect, variable, and in a state of constant degeneration and needed repair. This state of affairs may be changing as innovations in biomedicine and bioengineering make it possible to alter biological form and function. A belief in the technological ability to improve on the body's natural capabilities along with cultural assumptions about what is considered to be "deficient," "normal," or "enhanced" have led to a variety of body-altering techniques that not only repair or replace functions, but may go beyond what is typically considered therapeutic medical intervention. In essence, the ability exists to redesign the human body according to particular needs and desires, altering or building in new features.

This review considers how anthropologists and others have viewed these so-named enhancement technologies. There is no co-

herent body of literature; rather, works from anthropological and feminist studies of the body, social studies of science, technology, and medicine, bioethics studies, and disability studies explore aspects of body alterations and the cultural assumptions that underlie them. Also, the array of technologies are not yet well represented. There are numerous examples of cosmetic surgeries and procedures, some on pharmaceuticals used to improve performance (particularly cognitive enhancers), and a growing number of works on genetic and regenerative medicine, but surprisingly few exist to date on technological assists such as computerized prosthetics or, excepting cochlear implants, artificial organs that may have enhanced capabilities. This review focuses on technologies that have appeared since the mid-1980s and have been used primarily in wealthy societies where individuals are more likely to be able to access them, often outside the usual health care payment schemes.

One must consider many social and ethical implications, including the possibility of different life strategies and subjectivities for individuals and societies on several levels. The pursuit of enhancement technologies also indicates the kinds of decisions being made about the appropriateness of using biology to solve social problems such as aging, fairness and inequality of opportunity, and care of the self. As is the case with all technological innovations, enhancements exist in a nexus of complex social, political, and historical relations, media representations, and medical and legal definitions of disorder and well-being. Although the rise of consumer culture plays a role, bodily enhancements are about more than commodification processes. They are a manifestation of changing ways of thinking about biological and social life that is fundamentally transforming institutions, economies, and meanings.

Enhancement technologies are most commonly defined as interventions intended to improve human function or characteristics beyond what is necessary to sustain health

or repair the body (Pres. Coun. 2003). The difficulties inherent in attempting to analyze enhancements can be seen in this definition itself. What is necessary to sustain health? At which point does a repair become something more than restorative, and for which (and whose) purposes are interventions defined as “therapeutic”? For example, a prosthetic arm could be little more than a stick to stand in for a missing arm, a grasping tool, or a sophisticated device with computerized sensory response and beyond-human strength or flexibility. Tissue-engineered cartilage can be designed to withstand greater-than-average mechanical loads, making joints more durable than “normal.” Vision can potentially be restored enough to enable the blind to discern shapes and identify faces with some devices now in testing, but designers could also adapt the devices to include non-human spectra of light detection. Who could and should use such devices, and under which conditions? How are we to make moral judgments about enhancements, to discern which treatments are empowering or harmful or to decide which should or should not be allowed? Does the type of function make a difference in terms of cultural meanings or what societies find acceptable—that is, are cognitive improvements morally or socially equivalent to improvements in mobility?

The issues are clearly complex. First, it is difficult to distinguish between what is therapeutic and what constitutes enhancement. Whether anti-aging techniques are a way to stave off the suffering of degenerative disorders or a quest for immortality may depend on the conditions in which they are used (Post & Binstock 2004). What may be therapeutic in one circumstance may be considered an enhancement when used by healthy individuals and adapted for other purposes, such as the use of hormones to retard the effects of aging, neurochemicals used by healthy people to stimulate productivity, or beta blockers (heart drugs) used to avoid stage fright (Elliott 2003, Rothman & Rothman 2003).

Questions of what is being seen as deficient and what exactly is being enhanced, both biologically and socially, are also significant. Judgments about physical and mental characteristics differ among societies and traditions and over time. Martin (1992) has suggested that the drive toward productivity and flexibility in the United States has called for a new type of body, possibly specific to American culture: one that is vigilant, responsive, needs little sleep, and can work harder. If true, the average body may be viewed as deficient, and the conditions are conducive to acceptance of a variety of enhancements. Other societies, however, have different values around productivity and what counts as competence. As Lock (2000) put it, arguments about ills and deficiencies are moral disputes about the boundaries of normal and abnormal as well as the social significance of creating such boundaries. The relationship of economic factors and the hierarchy of cultural values will affect individual and social decisions about enhancements, particularly because not all individuals will be able to afford them.

Traditionally, the practice of medicine has been based on finding pathology. This deficiency approach focuses on causality of disability, variance, or disease and treatment that will bring the patient to a functioning state. Enhancement, by comparison, may or may not have a starting point of deficiency. The focus is on invention, redesign, and upgrading capabilities. To talk about what is viewed as needing fixing and what exactly is being enhanced, one must first consider the cultural assumptions that constitute “normal.”

## WHAT'S NORMAL?

The concept of “normal” is a relatively recent addition to the English language, adapted for use in biological states only around the mid nineteenth century. L. Davis (1995), Hacking (1990), Lock (2000), Porter (1995), and Sinding (2004) provide excellent accounts of the conditions that led to changes in thinking

about normality, health, and disease, including the rise of statistics. In brief, older ideas about the health necessity of balanced bodily states of excesses and deficiencies were augmented by later findings about pathology that could be generalized to populations. Measurements of individuals in populations were collected and yielded a distributed range of data points on everything from physical traits and intelligence to behaviors, initiating the concept of a “normal curve.” Most people will fall within the main range of the curve, but others are considered to be outliers. The further one is from the hypothetical statistically average person (the “norm” becoming the center point of a curve), the more likely he or she is to be defined as “not normal.” Canguilhem (1989) suggested that, in health, the idea of a normal curve was consistent with conceptualizing disease in terms of a continuum of qualities that constitute health states. Because of the state’s interest in using information to manage populations’ health and labor, however, distinct categories were constructed, creating a dichotomy of normal and pathological states.

Lennard Davis would call this an institutional state of “normalcy” (as distinguished from “normality,” the state of being physically normal). He understands this to be “the political-judicial-institutional state that relies on the control and normalization of bodies” (L. Davis 2002, p. 107). Key to the institutional state of normalcy is the use of statistics to delineate individuals into groups and describe their position as they fall within or outside of expected norms. Classifications and definitions can then be used by governmental or medical authorities to create guidelines for how to deal with things and people outside the norms. For example, the Americans with Disabilities Act in the United States and the National Survey of Disabled Persons in China could thus define who is normal or disabled, and consequently, who should receive which kind of care (Kohrman 2003). Outliers can more easily become targets for intervention, as Kevles, Pernick, and others demon-

strated with the history of eugenics. Physical conditions can be given political significance because the nonstandards may be perceived as costly to a society both economically and politically. It then becomes conceivable to attempt to “norm” the nonstandard or “defectives” using social-scientific programs (Kevles 2003, Pernick 2000).

Just as population statistics tell a state who and what is normal, quantifiable laboratory measurements tell individuals if they are normal or in need of medical intervention. Yet the growing phenomenon of using probability statistics to predict who may get a disease is creating new categories that are neither normal nor abnormal. Persons in the new “at risk” and “worried well” categories are urged to know their own risk profile and do something to bring themselves to a more normative state (Dumit 2003, Lock 2000, Rabinow 1992). Treatments may not be available, yet individuals are encouraged to consume products, change behaviors, and even intervene in their genetic fates (Buchanan et al. 2000). Adding new classifications of potential targets for enhancement, augmentation, and modification as new technologies become available is an easy outgrowth from categories of deficiency and normality.

Whereas statistics may be quantifications based on observations, perceptions of what constitutes normal or abnormal may be quite subjective. Canguilhem was interested in the way that norms are constituted by medical, legal, and social practices and narratives, making norms understandable only within particular contexts (Sinding 2004). For example, a measurement of a given population’s blood cholesterol level will yield an average and a range of actual points, but some parties (drug companies, insurers, or others) may have a strong interest in pushing the acceptable range lower for purposes of persuading use of therapy, selling a cholesterol-lowering drug, or avoiding potential illnesses linked with cholesterol. Observed behaviors not in line with moral customs, religious beliefs, or political regimes could also be labeled as abnormal

and either medicalized or criminalized, as has been done with homosexuality across societies and time periods. Levels of lead, mercury, or other contaminants can be defined as normal for certain amounts of exposure, but in the context of political debates over regulation of water or air pollution, either a narrower or wider tolerance range may be used.

A society using a concept of norms, where all people must fit somewhere along a distribution curve, differs significantly from a concept of the ideal, where everyone would fall short and no one is expected to have an ideal body. Nevertheless, Hacking (1990) argues that the idea of normality has a moral quality: The norm becomes the way we ought to be. Understanding competing concepts of norms is essential to the study of enhancements because as a norm comes to stand for something to strive for, rather than a centered, neutral, or positive condition, the average comes to be seen as the deficient. Judgments about natural characteristics, particularly as they relate to merit, may also shift, providing an opportunity for enhancements to be seen as maintenance or needed self-improvements, rather than a luxury or a fantasy of perfection.

## ENHANCEMENT TECHNOLOGIES AND BIOETHICS

Much of the existing literature on enhancement technologies comes from bioethicists (Parens 1998, Pres. Counc. 2003). It arose from debates about the increasing use of anabolic steroids and other drugs to enhance athletes' performances in the 1980s, as well as the expanding use of human growth hormone (hGH) for short children made possible with recombinant molecular techniques at about the same time. Primarily concerned with the moral permissibility of extending human capabilities, bioethicists were also occupied with questions about the obligations of physicians to provide certain treatments when they may not be warranted or medi-

cally "necessary" (Brock 1998, Daniels 2000). As the number and type of available enhancements expanded, many felt that enhancements should be thought of in the same category as futile treatments—that is, beyond medical responsibility.

Enhancement thus drew attention to the problem of defining the proper goals of medicine and distinguishing these from social goals and values. In the oft-cited case of hGH, for example, treatment for a child with a condition resulting in retarded growth would be considered therapy. However, a short child of short parents could also suffer social consequences because average or even tall stature may improve an individual's chances for life success.<sup>1</sup>

Ethicists Allen & Fost (1990) asked if it would be fair to withhold treatment just because it would not be medically therapeutic. In this logic, varying from the average can be constructed as a medical problem warranting intervention if normative views of social well-being are privileged. In American culture, the claim to fundamental values of equality of opportunity comes into play. As L. Davis (1995) put it, "Democracy needs the illusion of equality, and equality needs the fiction of the equal or average citizen. So with the creation of a representative democracy comes the need for an ideology that will support and generate the aims of normalcy" (p. 110). Yet other highly valued characteristics, such as competitiveness, may conflict with notions of advancement based on natural characteristics and merit.

Shapiro (2002, p. 774) argues that differing notions of equality may affect the way enhancements are valued, and vice versa. Equal opportunity (understood as rights against interference by others with equivalent access

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**hGH:** human growth hormone

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<sup>1</sup>A key ethical issue in such cases is proxy decision making for children. Decisions about some bodily changes, such as stature, the implantation of devices such as cochlear implants, or some genetic interventions must be made at early ages, raising the question of the interests of parents and caregivers and their own values regarding enhancement.

to enhancement resources) does not necessarily translate into better medical or social outcomes, however. Unequal outcomes that parallel existing inequalities in status, power, or wealth can still result. A “keeping up” atmosphere could be created because the more common an enhancement becomes the more the less able need it to avoid losing ground.

This phenomenon is evident particularly in sports medicine, where an intense drive to win, income incentives, and national competitiveness have made performance-enhancing techniques commonplace. Anabolic steroids have been the subject of considerable public controversy because of alleged abuses and health risks, and some of these have been removed from the market and outlawed from competition use. A somewhat different situation exists with erythropoietin and insulin-like growth factor (IGF-1), both of which were created to treat disease (anemia and muscle-wasting diseases, respectively) but have been taken up by athletes because of their effects on endurance and muscle building (Behar 2004). Such enhancements create an advantage specifically for sports activities (which are also work and income activities for professional athletes) but are currently seen in very different legal and regulatory frameworks than the enhancement of a normal person’s school performance with the use of attention-deficit drugs or one’s social performance with the adapted use of anti-anxiety drugs for shyness. It is far more difficult to police appropriate uses of treatments when they must remain available for the ill, and it is sometimes difficult to draw a clean line around “therapeutic need.” Objections to performance enhancement are based on the expectations of a level playing field and the idea that the dignity of human activity is diminished, as distinct from other forms of preparation of athletes, such as special training or nutrition (Pres. Council 2003, see especially Ch. 3). But these writings assume that sports are inherently fair and are played fairly, when

in fact the spirit of competitiveness allows for considerable latitude in techniques used to gain an advantage, just like war or competition for jobs or mates. At stake are cultural notions of individual merit and performance often symbolic of a nation’s collective ability.

Brock, Daniels, and other ethicists have attempted to create guidelines to simplify medical decision making: Treat only when medically necessary, treat when there is a need to eliminate something that puts a person at a disadvantage, or treat whenever someone has a desire to eliminate a characteristic (Brock 1998, Daniels 2000). This is an actuarial approach, which focuses on costs, benefits, and entitlements. For purposes of policy making, such classifications are useful, yet they presume the ability to locate an intervention in a grid of normal or abnormal states on one axis, with clearly defined boxes of therapy or enhancement on the other. Furthermore, they are problematic because of the difficulty in defining “disadvantage,” “necessity,” and “desire.” Is augmentation with a silicone implant after removal of a cancerous breast a cosmetic procedure or a therapeutic one? Beyond the question of whether it is medically necessary or advantageous—physically or psychologically—to replace that particular body part, the answer may determine whether societies or insurance companies must pay for them. Should physicians prescribe Modafinil only for its indicated use of narcolepsy and Alzheimer’s disease, or should they respond to requests to use it for off-label purposes, such as improved memory and mental performance in healthy persons (Farah & Wolpe 2004, Healy 2004)? The answer is linked with the way regulatory authorities view approval and policing of medications.

Such arguments expose a weakness of bioethics writings on enhancements, namely that they extrapolate the situation of individuals (often ideal-type) to society and universalize across cultures, societies, and time frames. The moral debates in this body of literature



about the nature of being human, the blurring of natural and cultural domains, and the intersections of medical and social goals have long been the focus of anthropological inquiry. Yet the overriding bioethics focus on Western notions of fairness and equity, risk, and prescriptive judgments for policy purposes excludes analysis of social disparities, differences in local political, economic, and health conditions, and differing value systems that are central to anthropological understandings of health and medicine. What might enhancement mean in a poor society where an artificial limb specially designed for working in rice fields or a bicycle designed to provide mobility means the difference in a person's ability to make a living? Compare these situations with a wealthy society, where an amputee might own multiple artificial limbs with sophisticated bioengineering designed for various sports. Anthropologists Kurzman (2003) and Kohrman (2003) and historians such as Serlin (2002) explore such questions through their studies of culturally specific responses to disabilities.

## ENHANCEMENT TECHNOLOGIES AND ANTHROPOLOGY

Anthropologists formulate questions in different ways: What are the relations among individuals, technologies, health care delivery systems, political ideologies, national commitments, and market conditions in various locales that produce, enable, or constrain certain enhancements? How do ways of ordering and valuing individuals, groups, and their characteristics affect the way bodily capabilities are seen? One has only to think of the way societies deal with aging to see how these relations shape what are considered appropriate interventions. Whereas some societies accept aging as a normal social and biological process, others see aging as a pathology to be overcome. Aging can be a social and economic problem for individuals (for women, in particular) and for societies if it is seen as representing reduced productivity and increased

risk for disease. The old may be perceived not only as having less value, but also as being a burden on society. At the same time, the desire for youthfulness, engendered by cultural privileging of youthful vigor, has led to high-priority research programs and commercial efforts toward the twin goals of extending lives and reversing specific age-related illnesses and physical characteristics (including the appearance) of being old (Juengst et al. 2003, Post & Binstock 2004). Competitiveness (whether for mates or for resources in local and global markets), consumer desires, political rationalities regarding the regulation of populations, and scientific concepts of temporal biological processes are all parts of the contingent social conditions that can produce enhancement technologies directed against aging.

Many anthropologists, influenced by Foucault's (1978) concept of bio-power, point to the relations of modern forms of power, which operate through bodily disciplines and modifications. Foucault's formulation was based on the observation that from the eighteenth century, forms of power changed such that repressive measures were no longer necessary or effective means of controlling people. Instead, political authorities controlled and improved the state by taking on the role of managing life itself. This role entailed making life an object of study, gathering information about individuals' lives and bodies. With this knowledge, administrative techniques could be employed to plan health services and regulate social life. This gave rise to modern life sciences, the clinic, and concepts of "health," "illness" and "deviance." The state could thus foster well-being while making citizens subject to regulatory control: Behaviors and bodies, disciplined through administrative means, would be productive, good citizens. Central to modern forms of power, however, was the need for individuals to internalize norms set forth by the linkage of intimate information, emerging institutions, and practices. "Technologies of the self" involve constant processes of self-monitoring and self-mastery, most of which

operate on the mind and body through medical means. Biomedicine thus became the means by which the quality of collective and individual lives could be improved.

As Rose (2001) points out, when human capabilities are couched in terms of biology, variation from norms based on population statistics can lead to the exclusion of those found to be inferior, and health comes to be seen as fitness of a particular sort. The public health, hygiene, and eugenics programs of the early twentieth century, operating on populations, gave way to self-help programs by the end of the century as the cost of defective citizens and their necessary support technologies became burdensome. The strategy of shifting the burden to individuals is couched in terms of personal empowerment, and individuals are reconceptualized as autonomous actors who can choose behaviors, practices, and most importantly, products.

Martin (2000) sees the shift to self-mastery as being related to the shrinking of social institutions traditionally relied on for well-being, support, and community. Forms of employment become less reliable as technological innovations accelerate change in work and social practices, employers downsize or outsource jobs, and national governments cede responsibilities to local authorities and alternate forms of governance. Wealth is becoming more polarized and often predicated more on backstage machinations and public performances than on meritorious labor. Martin (2000) argues that individuals then become more like "nodes in a network": "[T]he person comes to be made up of a flexible collection of assets; a person is proprietor of his or her self as a portfolio" (p. 578); that is, people identify and develop perceived, valued assets to position themselves properly within rapidly shifting flows of global capital. The distinction between traditional ways of preparing oneself through training or gaining new skills is that the new way of putting forth one's assets is through body modifications.

The politics of identity and the self can be linked to the rise of consumerism, accord-

ing to some social scientists. Turner (1996) and Featherstone (1991), among others, describe efforts to create identities and meanings through goods by illustrating the history of transformations in social life that resulted in increased attention to bodily practices. To summarize, after labor-saving devices and mass-produced goods became readily available to the public, leisure time expanded. This resulted in more free time and disposable income to spend on maintenance and pleasuring of the self. A consumer culture developed, driven by images of youth, beauty, luxury, and fun, departing from pre-World War I values of thrift and hard work. At the same time, less hard physical labor combined with diets characteristic of more prosperous (or at least less poor) classes led to changes in health status and obesity. Increased attention was paid to maintaining the body, for both social and aesthetic reasons. However, individuals, rather than governments or institutions, were now deemed responsible for their own maintenance. Neglect was seen as laziness, low self-esteem, and even moral failure. The body became a project through which self identity was constructed, particularly identity as a good, productive citizen. But body maintenance requires the consumption of goods, turning the wheel of desire, production, and consumption, and key to creating desire was the circulation of images by commercial interests, as Bordo (1998), Featherstone (2000), and others have demonstrated in their analyses of advertising and health promotional campaigns that promulgate specific images of the ideal body and person.

Ironically, as individuals select among bodily practices and modifications to suit both external expectations and a sense of fulfillment, a question of authenticity arises. Elliott asks the question, is this an authentic self or one invented by altering the biology (through surgery, medicines, or devices) and imagined through advertising, media, health advisory groups, or other images (Elliott 2003)?

In her study of assisted reproduction, Strathern (1992) observes that the ability



to augment biology occurs within the context of what she calls enterprise culture—the nexus of technoscience, consumer desire, and contemporary medical marketplaces. In her view, marketing and cultural expectations of how the body should perform are central to shaping the relationship of bodies and technologies. To illustrate her point, she discusses the way produced goods are designed for selling as much as for use, with attributes made explicit to consumers in ways that meet their cultural expectations. “To select an apple for its appleness is to discriminate between those which conform more or less to cultural expectations about what the natural apple should be” (p. 39). Although her example uses a common commodity and not humans, her point is that there is a collapse in the difference between what is taken for granted in nature and what is perceived to be the result of human effort. This is instructive for human enhancements because the work that goes into both identifying and amplifying certain characteristics as being amenable to change and constructing certain traits as desirable does more than essentialize them as preferred human traits. Rather, it forms a circuit of enterprise, biology, medicine, and culture in complex relations to each other. In this sense, the traits being enhanced are not inherently natural but cultural. This finding is evident in regenerative medicine, in which the body itself is directed to do engineering-guided, self-repair according to specified, desired characteristics (Hogle 2003). The concept of culture itself is changing as the technologies used to modify bodies—to “assist nature” as Strathern (1992) puts it—become so integrally bound with biology that it is impossible to think of natural and cultural domains as distinct. “Technology literally helps ‘life’ to ‘work’”(p. 60).

In the early 1990s, a body of literature collectively called cyborg anthropology formed a linkage of anthropological works in science, technology, and medicine with the social study of science, technology and society, and sociology of knowledge. Inspired by key works such

as Haraway’s (1985) landmark “Manifesto for Cyborgs,” writers considered a range of topics in the physical and life sciences, many of which explored emerging relationships and intimate connections between technologies and bodies (Gray 1995). Haraway, a feminist historian of science, used the image of the cyborg to explore such boundary crossings, including the ability to create chimeras, human-machine entities, virtual communities, and other forms of biological and social life. From a perspective that refuses discourses about purity and natural categories, Haraway creates opportunities to analyze the various ways that subjectivity and agency are being transformed. At the same time, changes to the body are positioned within the reconfigurations of technoscience and multinational capitalism, which she terms the “new world order” (Haraway 1997).

The cyborg as both a technological artifact and a cultural icon is central to understanding the new relationships between bodies, information technologies, and technologies used as prosthetic extensions, according to Hayles (1999). The seamless articulations among humans and technologies make it clear that the concept of an autonomous, bounded subject is giving way to a different kind of subjectivity, which she calls the posthuman. The cyborg literature thus challenges romanticized notions of a pure or natural self that should not be tampered with, a notion that characterizes much of bioethics and social science literature.

Much has been said about the culture of perfectibility promised by the marriage of technoscience and consumer markets (Kalb 1999). However, the phenomena of enhancement technologies may not be so much a pursuit of perfection or immortality as much as a way of controlling, designing, and planning the body as an integrated unit of biology and technology (Hogle 2003). Enhancements are upgrades. Upgrades support scientific research agendas and the ongoing production of goods and services that suit the needs of global exchanges. At the same time, the ability

to engineer bodily functions gives currency to the illusion of controlling predictability in an unpredictable world. From this viewpoint, if environmental stressors and social ills are too large a problem to tackle, and trauma or war is too unpredictable or technology too necessary to change, then the injury to bodies must be made fixable. In the emerging ethics of enhancement technologies, bodies made to be resilient, more enduring, and attractive will be prepared for any contingency of social life, labor, or global condition (Hogle 2004a).

## THE TECHNOLOGIES

### Cosmetic Procedures: Free to Be Me?

For many people, the term bodily enhancement first conjures images of plastic surgery. Indeed, the development of surgical and prosthetic techniques, along with social concerns about aging and fitness and a reliance on body modifications to deal with these concerns, has made such procedures commonplace in the twenty-first century. There are two types of plastic surgery: reconstructive procedures performed to correct congenital abnormalities or damage from an injury, and cosmetic procedures performed not as a treatment for illness. Both depend on judgments of physical and social function, but also are related to ideals about visible appearance.

Physical appearance has cultural importance in terms of identity and notions of beauty, but also has been used socially and medically to evaluate general well-being and even moral behavior, particularly before the advent of diagnostic instrumentation. Writing about the history of eugenics, Proctor (1988) and Weindling (1990) explain how measurements of body symmetry and proportion were central to definitions of fitness. Visible impairments and anomalies were used to cull out those who varied too greatly from the imagined ideal form and subjected them to various interventions. Such normalizing,

racialized thinking about appearance can take extreme forms, as in the linkage of hygiene to the cult of beauty and bodily perfection that occurred in pre-world war Germany (Hau 2003). The medicalization of appearance in such ways has had a lingering influence on perceptions of visible variation and disability. Social and medical judgements of certain traits as desirable or undesirable serve to make the body an object to be “corrected.” Cosmetic surgery then becomes a technology through which the body is normalized and homogenized as much as enhanced.

Haiken (1997) demonstrated the relation of beauty culture to surgical innovations after World War I. As she explained, demand for technical expertise in reconstructive surgery and prosthetics increased owing to the massive number of injuries from war. But expanding this area resulted in an excess of expertise and investment in the postwar era. Surgeons began looking for ways to extend their practices, including dealing with aging bodies. Americans were healthier and more prosperous after the war than ever before and were thus more capable of enduring and paying for elective procedures. In a time of growing consumer culture, the time was ripe for a professional specialization of aesthetics.

At about the same time, the second wave of immigrants came to the United States from eastern and southern European countries. Gilman’s (1999) work emphasizes the importance of passing for those who looked different to be acceptable to mainstream society, most of whom were northern and western European descendents (1999). Haiken (2000) points out that nose and facial surgeries were used to deemphasize ethnic features because of concerns about anti-Semitism and racist attitudes engendered by the growing interest in eugenics in the early twentieth century. Today, procedures to minimize ethnic features, including skin lightening, nose and lip reduction, and removal of eye folds, are resurging (Haiken 1997, Kaw 1993). Kaw interviewed Asian American women and plastic surgeons

about ethnic modification procedures, finding that both groups reinforce stereotypes of Asian features that they believe belie traits of dullness and passivity (see also Serlin 2002 on Western interpretations of plastic surgery for Asians). Kaw concluded that the women internalized American values of assertiveness and quickness and changed their appearances to match.

Notions of attractiveness or proper appearance may be culturally specific in some ways, yet Featherstone (1991), among others, argued that through globalized consumerism and images projected through the media and advertising some homogenization is occurring, with a preference for Westernized appearances that may be connected to beliefs about success and well-being. In later works, he further suggests that there is a temporal aspect of body modifications that parallels the fluidity of identity in modernity: Images can be borrowed from other cultures or time periods or changed to associate with certain groups (Featherstone 2000). There is a paradox of conformity to an imagined norm and a desire to express individuality that characterizes wearable fashion. This finding can be seen in the increasing popularity of non-surgical treatments and so-called lunchtime face lifts that are performed in about an hour, usually in an office setting, and are priced to make treatments more affordable than a surgical procedure, which can cost several thousand dollars.<sup>2</sup>

The results are transient, lasting from a few weeks to months, requiring periodic repeated treatments. While giving the impression of being able to opt in and out of participation, the effect of repetition is to draw continual, deliberate attention to worries about aging and appearance. Ironically, there are other procedures with permanent effects that re-

spond to transient fashions, including collagen injections to foot pads and the shortening of toes to suit shoe styles, nipple enhancement and navel repositioning for tight or revealing clothes, and modification of specific parts to mimic favorite movie stars (Kalb 1999).

The number and types of cosmetic procedures are proliferating, which indicates that it is not a preoccupation with youth or beauty alone and not just older, wealthier women, as stereotypes suggest. There were 8.3 million procedures done in the United States alone in 2003, a 20% increase over 2002. Of these, 37% of patients had previously had at least one procedure, and a growing number are having multiple, simultaneous procedures (Am. Soc. Plastic Surg. 2004).<sup>3</sup>

The majority of procedures are purchased by those individuals with annual incomes less than \$50,000, and 20% are purchased by individuals younger than 34 years of age, including a growing number of teenagers having liposuction and breast augmentations (Am. Soc. Plastic Surg. 2004, Kalb 1999). Penises, breasts, and calf and pectoral muscles are enlarged while thighs, arm flaps, and abdomens are diminished or “sculpted.” Among the fastest-growing procedures, however, are hand vein reductions and chin and hair implants, changes that individuals claim give them a competitive advantage in work fields where appearance is important. Here we see an implicit link of appearance with perceptions of competency and productivity. Identity politics, consumer culture, perceived competition for jobs or partners, institutional contexts, and technology all contribute to the demand for aesthetic body enhancements.

<sup>2</sup>Nonsurgical treatments include botox injections, chemical peels, or the use of collagen to remove wrinkles and plump skin or to fill in lines or acne scars with collagen, gel-like materials, or calcium-based materials. The skin can also be evened with acids or sanding materials.

<sup>3</sup>The latter phenomenon may have stimulated—or have been stimulated by—the explosion of television reality shows depicting “total makeovers” for men and women. Televised competitions judge people not necessarily for the best surgical outcome but the greatest overall change, including transformations in clothing and psychological disposition. This speaks to the ways individuals seek to manifest spiritual, mental, and physical performance from bodily modifications.

The most significant debates in recent years, however, insist that cosmetic practices must be situated in discourses and practices of gender (Negrin 2002). Basalmo argues that no matter how fashions of appearance change over time, the principles are the same in that individuals are responsible for their own beauty and for embodying the ideal of their sex (1992). Gender, she argues, organizes our interpretations and treatments of bodies. Men with tanned, leathery skin or graying temples may be perceived as physically active or authoritative, whereas women with similar characteristics may simply be seen as old and unattractive.

K. Davis (1995), among others, believes that cosmetic surgery is usually seen as more acceptable for women because they are expected to have low self-esteem. In her ethnography of western European women, however, she argued that women are not simply passive victims of commodification and consumer culture. Rather, bodily imperfections may spur women into action, and through a desire to improve themselves, they become active agents in changing their position in society. Having surgery can thus be a form of empowerment. Bordo (1998), however, argues that it is difficult to think of choice of procedures outside of cultural norms and the gendered practices of power and authority. Many such norms may be harmful, she argues, because by accepting and participating in cosmetic procedures, negative messages become reinforced and pressure is increased for other women to participate. Furthermore, there will always be more deficiencies to fix because the female body is always seen to be in need of regulation and constraint (Bordo 1998, Turner 1996).

Some scholars say gender differences in bodily experiences are converging in globalized modernity. Both Bordo and K. Davis are skeptical of this stance, stating that although taboos are lessened, there are unequal pressures of cultural ideals of beauty, and differences remain in the way men and women experience their bodies and embodiment (Bordo

1999, K. Davis 2002). K. Davis (2002) feels that cosmetic surgery cannot “enhance” masculinity for men in the same way it “enhances” femininity for women for the simple reason that the very act of having surgery signifies a symbolic transgression of the dominant norms of masculinity (p. 59). In the cultural meanings associated with masculinity, Davis argues, the body and its vulnerabilities must be hidden and denied, and men who admit they are suffering—and do something about it through interventions—are acting “feminine” (see also Dutton 1995 on masculinity and the male body).

### Cyborg Prosthetics

The icon of the cyborg, as previously described in Haraway’s work, embraces the idea that one can choose one’s own embodiment. As performance artist Stelarc puts it, “this is evolution by the individual for the individual” (Stelarc 2004, personal communication; Zylinska 2002). The body becomes a set of relations, rather than a package with some form of agency. Technological prostheses provide good examples to think about the evolving nature of subjectivity and agency, as they may be far more than mere extensions in an attempt to regain bodily unity.

As Serlin (2002) and others note, disfigurements create public anxieties about their own vulnerability and autonomy. For those with missing or disfigured parts, passing as able-bodied is important for social as well as physical functioning. Although there is an extensive literature on disability in its various forms (amputation, sensory loss, physical malformations, or mental disorders), there are fewer works on prosthetics or how prostheses affect embodiment and identity. Notable exceptions include a collection of histories of prosthetic design and use (Ott et al. 2002, Serlin 2002) and an ethnography of limb prosthetics in the United States (Kurzman 2003).

Designs that take the form of a mere structural replacement complete the fiction of “filling in” the missing part, but other designs may

allow for specialized or enhanced functions, such as tools that grasp or articulate specific to sports or work needs or arms that are more durable than human flesh and do not suffer fatigue. Sophisticated, computerized limbs may have sensors to fine-tune balance and spring or operate in response to bodily electrical impulses. These kinds of things beg the pragmatic question, of course, of who gets access to which level of enhancement (Brock 1998). Beyond this, however, is the fact that like all technological objects the replacement is not a neutral adjunct to the body; rather, depending on the context in which it is used, a new subjectivity may be created for the user, and new meanings of embodiment may be created.

Journalist John Hockenberry (2001), himself a paraplegic, celebrates the advent of enhancing assistive technologies such as miniature wireless devices and voice simulators. In an article subtitled “Your Body: Get Over It,” he describes the world of the disabled and their relations with assistive technologies. One immobile patient who has subcranial cortical implants producing muscle motion through brain signals was able to move a cursor on a computer screen, begging the question, “because of the implant, is a Dell Pentium cursor now more a part of [the patient] than one of his own paralyzed arms” (p. 96)? Hockenberry describes the experience of optimizing brain-machine interfaces by likening it to being like a puppet; that is, improvising motion by merging available body functionality (arms, neck, head) with a small arsenal of customized machines (wheelchairs, grabbers, remote controls) (p. 101). Functional electronic stimulators, deep brain stimulation, neural prostheses, and other direct brain-technology interface devices, as well as communications technologies, do more than substitute function for the disabled; they transform the experience of movement, balance, and communication. According to a Cyberkinetics company spokesperson, “we can help people who are disabled become superable in a new sense. These people may be able

to do things we can’t do, like operate a computer faster or do very precise tasks” (Kotulak 2004).

Contrary to arguments about identity and body image in the previous section on cosmetic procedures, Hockenberry (2001) suggests that the history of assistive technology for the disabled shows that people will sacrifice traditional body image if they can have equivalent capabilities: “The greatest thing people with disabilities have done for the general population is to make it safe to look weird” (p. 101). Not surprisingly, many assistive technologies such as screen readers, text enhancers, and voice simulators are being adapted for use by healthy individuals, primarily for learning purposes and enhanced productivity (E. Morrison, personal communication).

Blume (1997) analyzes another bionic technology, examining the complex moral and medical issues concerning cochlear implants for children (1997). Designed to provide the Deaf with some ability to amplify and discern sound, the assumption of designers was that Deaf people are disabled and in need of a bionic ear. Many of the Deaf, however, think of themselves not as being disabled but as having a community identity based on a particular variance. They resisted the drive to bring them to a normative state through a technological intervention, comparing hearing enhancement to racism and other forms of discrimination.

### Cognitive Enhancement

If cosmetic body enhancements rely on cultural explanations and attempts to achieve social outcomes using medical interventions, then neurological enhancements rely on a biological reductionist assumption that all behavior, interactions, and physiological functions are related to neuronal structures. This perspective erases the social, creating a subjectivity reliant on assistance (Rose 2003). To make a person happier, more outgoing, or better able to perform mental tasks, then, requires

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**ADD:** attention deficit disorder

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taking psychopharmaceutical drugs. A partial corrective to assumptions of universal biological reductionism is found in Lakoff's (2004) study of antianxiety and antidepressive drugs in Argentina. In his ethnography, globalization and economic insecurity are used as the model of depression rather than biology.

Chemical enhancers purport to help people sleep less, work harder, and have greater mental acuity. Although little clinical evidence supports this claim, the belief that performance is enhanced is enough to create a soaring demand for off-label uses of drugs designed for Alzheimer's disease, narcolepsy, and attention deficit disorder (ADD) (Hall 2003). Hall details some evidence of the growing use of chemical enhancement from sales figures, such as \$200 million per year for Modafinil, far more than the market for narcoleptics would need. The explosion of diagnoses of children with ADD and the subsequent high number of prescription requests for Ritalin and similar drugs (already suspect in terms of improper diagnosing and medicating of behavioral states) has now been extended to adults. Those who have difficulty concentrating or wish to perform better on certain tasks are urged to get a diagnosis of ADD and consume this class of stimulant drugs. Hall, a veteran journalist who covers ethically controversial technologies, brings attention to an important social aspect of what he calls the "brave new pharmacology" by highlighting the relationships of drug industries and a regulatory regime geared to evaluate certain forms of risk.

Memory is a particularly significant and symbolic capability, receiving renewed attention because of the fears of senility among aging baby boomers but also because of the recent studies of posttraumatic stress and false memory syndromes. A prosthetic hippocampus (part of brain where memories are processed) is a microchip designed to recreate memory processing. Funded by the military, researchers are testing to see if chips could replace parts of the brain or at least relay mes-

sages in patterned ways (Hoag 2003). Potentially, a type of synthetic memory could be implanted, such as how to perform routine activities for individuals with Alzheimer's or other memory loss ailments.

Many brain-electronic devices are under investigation for military uses, for example, for pilots to make split-second decisions regarding flying and weapons discharge (Gray 2001, Talbot 2002). In fact, about 10% of the Defense Advance Research Projects Agency budget is devoted to the Brain-Machine Interface Program (Hoag 2003). These examples show the traffic across medical, commercial, and military domains that impact bodily modifications (Hogle 2004a).

Elliott (2003) uses interviews with patients and psychiatrists to conclude that in many cases, people seek changes in their identity and behavior with psychopharmaceuticals because they seek authenticity. Kramer (1993), in his landmark book *Listening to Prozac*, explored the same issue when patients reported that they felt "more like themselves" on Prozac than without. Elliott's primary critique of this phenomenon is that pharmaceutical companies capitalize on the late modern trend of obsession with personal identity by marketing an array of drugs as a key to self-fulfillment and the removal of barriers to the "real" self. In the market-driven economies of the West, he explains, antidepressants are sold for a variety of personality problems besides clinical depression, such as "social anxiety disorder" and "premenstrual dysphoric disorder," medicalized conditions hyped through illness awareness campaigns and faked support groups (Caplan & Elliott 2004, Dumit 2003, Elliott 2003). Similarly, using examples of the rapid sales growth of psychiatric drugs in the United States, Latin America, Africa, and Asia, Rose (2003) shows how strategic marketing practices of drug firms are aligned with the reframing of the self and illness in modernity, in which individuals must identify problems as neurological ones and then become active agents in change by consuming neurochemicals.



The brain is considered to be the organ of mind and consciousness and, particularly in Western cultures, the locus of selfhood. As such, neurological interventions have different ethical implications than do other body parts, according to Farah & Wolpe (2004). The basis for ethical concerns, said Farah & Wolpe, is that persons are responsible for good or bad actions and must take the responsibility, blame, or praise. Improving brain behavior pharmacologically may detract from the responsibility of the person for his or her own actions and reduce the effort needed for personal accomplishments.

Elliott, Fukuyama, and other commentators worry that people are simply trying to eliminate troublesome behaviors and feelings (Elliott 2003, Fukuyama 2002, Pres. Council on Bioethics 2003). Elliott views this as a pursuit of happiness while attempting to avoid the difficult, real problems of everyday life. Not only does the use of technologies to avoid emotional discomfort ignore possible risks, but also such consumption for the sake of individual enhancement ignores long-term consequences for society. Will this cause a ramping-up effect? What will it mean to have large numbers of neurally medicated people? Caplan dismisses such concerns about social changes and commercialization. He argues that attempts to achieve better performance should not be squelched and self-improvement techniques should not be restricted because science should be allowed free rein for discovery. Furthermore, because there is no agreement on what constitutes human "nature," detractors cannot successfully argue that there is an essential humanness that is threatened by such technologies (Caplan & Elliott 2004).

Existing writings on cognitive enhancements resonate with bioethicists' more general concerns about fairness and identity in the use of enhancements but also underscore the neoliberals' claim that the responsibility to deal with social inequities and the difficulties of modern life has shifted to individuals, not societies. The difference lies in how individ-

uals are expected to deal with social suffering: bear it or medicate it.

What is missing in the current literature is a more nuanced view of neural self-improvement activities as they relate to varying models of productivity, work, and life management in different societies. For example, in her new work, Martin (2005) points out that what is valued in American society as productivity are actually forms of mania. The aggressive, hyper-productive, creative, unpredictable behaviors that represent one extreme of manic and bipolar disorders are desired characteristics of corporate and world leaders. So, on the one hand, people may self-medicate to become more manic-like, whereas on the other hand those with true manias may be rewarded for not medicating their disorder.

## Genetic Enhancement and Regenerative Medicine

Perhaps the most publicly debated technologies that promise to modify human biology involve genetics.<sup>4</sup>

The array of interventions are described most completely in bioethics literature (Buchanan et al. 2000, Pres. Council 2003). Such work shows the myriad ways life itself

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<sup>4</sup>Some clarification is in order. Genetic tests can predict the probability of a disorder (such as breast cancer or Hodgkin's disease) and can detect the presence of a gene mutation in an unborn embryo or fetus, indicating an abnormality or potentially life-threatening condition. With this information, individuals can choose to undergo prophylactic treatments (if they exist) or terminate a pregnancy, but the condition cannot be eliminated without a proven gene therapy. Gene therapies, by comparison, are designed to replace or modify genetic structures to produce normal function (as in the case of inserting a missing gene required to make key proteins), or potentially, to improve function (as in the case of using IGF-1 to build muscle). Somatic cell therapies work on body cells (for example, in an adult with a genetic metabolic disorder) and affect only the individual being treated, whereas germ-line therapies could be used to affect future offspring (for example, in the attempt to prevent a known hereditary disorder from being passed on to future generations).

can be changed as biology-as-information is made malleable.

Social science work on genetic interventions is growing but is still speculative and exploratory, for the most part. Ethnographies of particular genetic disorders are appearing (Rapp et al. 2001), as are a few collections of commentaries on social and ethical implications (Goodman et al. 2003). Anthropologists are observing the new kinds of sociality, including kinship relations (Franklin & Roberts 2005, Strathern 1992). In a now classic article, for example, Rabinow (1992) illustrates how bio-power works with the new genetics: New forms of sociality are being created with groups whose identity has to do more with their genome profile or calculable genetic risk than with traditional ways of identity-making through communities. Some anthropologists, however, are beginning to take on the work of following global capital, as genes become trade entities (Franklin 2001, Sunder Rajan 2003).

Rabinow (1996), who took an early lead in recognizing the fundamental changes engendered by the Human Genome Project, remains one of the few anthropologists willing to do the more difficult work of fieldwork in complex technical settings to learn how specific techniques of identifying, amplifying, and selling the resulting information and methods led to groundbreaking ways of manipulating genetic sequences. His in-depth interviews with biotechnology scientists and managers illuminate the ways such processes enable the use and reordering of information about life to transform biology and society. There are numerous ethical and social concerns about genetic alterations. Defining and regulating ethically permissible interventions—including what counts as normal—have proven to be difficult. Scully & Rehman-Sutter (2001) wrote that “positioning the interface between permissible and nonpermissible interventions at the same place as the boundaries between therapy and enhancement, and between normal and abnormal embodiment uses biology to justify a

moral evaluation, privileges the single standpoint of the genetically canonical person and enhances the dichotomy between ‘normal’ and ‘not normal.’ This distracts from the work of uncovering the real grounds to setting limits to genetic manipulations” (p. 87). The National Institutes of Health in 1997 attempted to create guidelines for interventions but was unable to agree on what was acceptable, or what constituted an unwarranted enhancement, so they abandoned the process (Rothman & Rothman 2003).

Fukuyama (2002), political scientist and appointee to the President’s Council on Bioethics, in his widely cited book on medical innovations argues for a return to an ethics based on natural rights. This philosophical view holds that there is a universal human nature on which “oughts” can be derived and that rights (not interests) should organize human ends and goods. From this standpoint, genetic engineering and all other forms of enhancement would be rejected because it threatens human essence, and hence, human sanctity. An opposing view is held by transhumanists such as Bostrom (2003), whose goal it is to promulgate the improvement of human life through technology. Transhumanists believe that human nature is a work in progress, changing in relation to varying social and temporal conditions (Bostrom 2003). In this view, attachment to personal identity or something called human essence is not a priority. Genetic engineering through this lens is seen as an opportunity for new experiences and human growth. Although he cautioned against certain kinds of modifications (for example, manipulating traits such as aggression to a point that makes future generations too passive), Bostrom dismisses concerns about germ-line engineering’s permanent effects on future generations by offering the possibility that changes can themselves be changed in the future.

As yet, there are few in-depth analyses or ethnographies of genetic interventions, particularly regarding enhancements. Because

many genetic enhancements have not yet been made functional and are not generally available, investigators cannot yet study individuals or families and their decisions around such interventions, but there is a need to understand the assemblages of capital, scientific theories, and assumptions about nature and culture being built into emerging enhancement genetic techniques. In the emerging area of behavioral genetics, for example, traits such as intelligence and behaviors are being targeted for intervention, but there are complex, higher-order relationships with proteins, chemical signaling processes, and environmental effects. The need is urgent because in addition to creating selective advantages for individuals, the underlying ideology of personalized medicine that drives efforts to intervene in individual genomes will transform the way medicine is conceived and delivered. For example, nutrigenomics and pharmacogenetics are sets of technologies that seek to custom-design drugs and nutrients that respond specifically to individuals' particular genetic combinations. Rather than considering the health needs of a population, there is a growing interest in developing diagnostic and therapeutic interventions and services meant to contain risk at the individual level. Such services will be expensive, ignore social and political causes of disease and disorder, and are often bound to biological constructs of race and definitions of risk. In the process, definitions of health, normality, and deficiency will be reformulated.

A segment of the sizable literature on reproductive medicine has focused on technical assists to reproduction (which will not be covered in this review), but is turning attention to trait selection that can occur during assisted reproduction procedures. This may involve altering or selecting for certain traits in an embryo and the selective embryo implantation or genetic screening and selective abortion to select traits (Buchanan et al. 2000). Often perjoratively called "cosmetic genetics," selection may be done to eliminate embryos with genes for life-threatening disorders or to

choose traits such as hair or eye color, body build, or sex.

One such controversial technique is preimplantation genetic diagnosis (PGD). For cases where there is a high potential for serious genetic conditions, unaffected embryos can be selected for implantation. In a much-welcomed anecdote to the judgements about reproductive genetics "from above," Franklin & Roberts' (2005) ethnography of couples undergoing PGD took a close look at the legal, ethical, social, and family contexts in which couples had to make difficult decisions about whether to risk proceeding with a pregnancy that might result in a child who dies prematurely or selecting embryos to implant, knowing full well the ethical and moral implications of their choice. Fukuyama (1992) worries that parents will choose features on the basis of thinness fads or other "politically correct" features (p. 93). However, contrary to such popular PGD representations as creating "designer babies" for trivial or self-interested reasons, Franklin & Roberts depicted couples who were highly sensitive to the related ethical issues regarding not only their own choices, but also the way those choices affected broader social and policy arenas. In this sense, the couples, along with legislators, physicians, counselors, and others, participated in innovating new ethical and social pathways.

Tissue engineering (TE), stem cells, and anti-aging techniques, collectively referred to as regenerative medicine, are among the most significant transformative technologies. As Franklin (2005) puts it, "What is evident. . . are emergent models of human life in which who we are, and what we are made up of, can be extracted and utilized in ways that are not only about the reuse of existing parts, but their redefinition" (p. 63). Stem cells are early-development cells that can mature into almost all tissues given the right circumstances (growth factors, wound healing processes, and chemical signaling, which can all be produced in the body or staged in the lab), making them powerful therapeutic tools for repair and replacement. In a strict sense, stem cell

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**PGD:**  
preimplantation  
genetic diagnosis

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technologies are not true enhancement technologies any more than are other therapies that improve health. But in one of the only ethnographic explorations of stem cell science, Franklin makes the point that stem cells, as both technologically assisted and naturally pluripotent, are potential enhancers of human life that are themselves already enhanced. Removed from their bodily habitats, the cells have been altered from either embryonic or adult states to survive under foreign conditions and perform specified tasks. It is their capacity for self-transmutation that promises a source of never-ending, flexible augmentations. Most relevant for the study of enhancement technologies is the way engineered cells and tissues constitute a different sort of exchange economy, where supply is theoretically readily available yet restricted by politics and new market forms and the value comes from the fact that it is human material, something previously thought not to be tradeable as a commodity (Franklin 2001, Waldby 2002).

The ability to generate whole, complex tissues requires fabrication techniques that may involve combinations with synthetic materials in ways that go far beyond enhancement techniques found in prosthetics design or genetic techniques alone (Hogle 2003). TE combines knowledge from developmental biology, biomaterials science, and chemical engineering. In this way, TE goes beyond reproducing function (as in organ transplants or artificial parts) to understanding and re-designing fundamental life processes, using directed self-assembly and other engineering techniques. With this knowledge, it is possible to design human biological materials to desired specifications. In fact, tissue engineers are working on artificial tissues that are potentially stronger, more resilient, and more functional in terms of cell signaling and protein interactions. Although most were just trying to find workable biological substitutes, many of the researchers I interviewed felt it was an inherent part of their responsibility to create something better than human.

Importantly, tissue engineering and stem cell science are productive and enhancing in another sense. That is, by establishing infrastructures, linking research and market structures with innovating business models in conjunction with health care policy strategies, scientists and managers stabilize these emerging fields in ways that will enable further development of enhancement technologies (Hogle 2004b).

## CONCLUSIONS

Corporeal sufficiency as perceived in normative legal, political, medical, and cultural narratives becomes a reference point for considering what is necessary or desirable for a properly functioning body. But notions of sufficiency change as expectations of what it takes to sustain life changes in various political, economic, and social contexts and across time periods. The ability to create alternate body forms and functions already exists, and many novel ways of enhancing human capabilities are emerging that will have broad effects on individuals and social life. Descriptions of the variety of enhancement technologies and their ethical and social implications are most substantial in bioethics literature and popular media accounts to date. Many of the ongoing investigations of subjectivity and identity, knowledge production, and the relation of technologies and the body, however, have laid the groundwork for important future work on emerging enhancement technologies and the body.

Creating and sustaining enhancement requires work. Scientific and managerial practices and techniques, cultural assumptions about normality and deficiency, consumption behaviors, commodification and exchange processes, regulatory forms of power, and institutional contexts interact to create new forms of agency and sociality. In addition to considering enhancement within cost-benefit or entitlement-based frameworks as bioethicists often do or studying potential forms of exploitation, risk, social justice,

and other concerns as many social researchers do, anthropologists should consider the social conditions and processes that shape enhancement technologies.

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