Enhanced Warfighters: Risk, Ethics, and Policy

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Index

Executive Summary

The United States military is making substantial investments to develop technologies that would enhance the ability of warfighters to complete their missions safely and effectively. Driven by neuroscience, biotechnology, nanotechnology, robotics, and other emerging technologies, this research includes combating sleep deprivation, improving cognitive performance, increasing strength, reducing muscle fatigue, and other enhancements to the human body and mind.

As with other emerging military technologies, such as robotics and cyber-capabilities, human enhancement technologies challenge existing laws and policy, as well as underlying ethical values. But while the implications of human enhancement generally have been widely discussed, little analysis currently exists for the military context—specifically operational, ethical, and legal implications of enhancing warfighters, such as:

How safe should these human enhancements and new medical treatments be prior to their deployment (considering recent controversies such as mandatory anthrax vaccinations)? Must enhancements be reversible or temporary (considering that most warfighters will return to society as civilians)? Could enhancements count as "biological weapons" under the Biological and Toxin Weapons Convention (considering that the term is not clearly defined)?

This report begins an investigation into these and other issues in order to identify problems that policymakers and society may need to confront. We start with an analysis of international and domestic law, military policy, bioethics, and risk assessments. Then we offer a new framework for evaluating human enhancement technologies in a military context. As an initial model, we also discuss further considerations—related to character and honor, as well as broader social impacts—that can be integrated later into this evaluative framework.

Given a significant lag time between ethics and technology, it is imperative to start considering the issues before novel technologies fully arrive on the scene and in the theater of war. Consider, for instance, the sudden explosion in number of robots in war and the ensuing confusion and controversies over their use. This report, therefore, is intended to help avoid similar ethical, legal, and policy surprises, as well as technology misuses that affect national reputations and real lives.

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1. Introduction

War is an all-too-human affair, and it perhaps will always require payment in human lives. This is a terrible cost, but one which science and technology hope to ease. History has seen an evolution of defensive and offensive technologies—from shields and body armor to more accurate and longer range artillery—that are aimed exactly at minimizing the human cost, at least to our own side. In the Digital Age today, we are inventing entirely new and imaginative paradigms with military robots, cyber-weapons, and other technologies that promise to replace the organic, soft-bodied combatant and better protect noncombatants as well.

Yet it is difficult to imagine a plausible scenario in which human combatants will never be needed in war, no matter how advanced our technologies may be. No weapon or losses have been so horrific as to deter us from fighting again, as we have learned since World War I, quaintly billed as the "war to end all wars." Even against daunting odds and fearsome machines, from tanks to flying drones, humans are tenacious and hopeful, refusing to give up so easily.

But therein lies a fundamental problem with how we wage war: As impressive as our weapon systems may be, one of the weakest links—as well as the most valuable—in armed conflicts continues to be warfighters themselves. Hunger, fatigue, and the need for sleep can quickly drain troop morale and threaten a mission. Fear and confusion in the "fog of war" can lead to costly mistakes, such as friendly-fire casualties. Emotions and adrenaline can drive otherwise-decent individuals to perform vicious acts, from verbal abuse of local civilians to torture and illegal executions, making an international incident out of a routine patrol. And post-traumatic stress can take a devastating toll on families and add pressure on already-burdened health services.

Human frailty is striking and inescapable. Unlike other animals, we are not armed with fangs, claws, flight, venom, fur, or other helpful features to survive a savage world. It is a wonder our naked species has survived at all, if not for our tool-making intellect and resourcefulness. But our tools so far provide limited sanctuary from dangers. For instance, some estimates put the United States government's investment in each soldier, not including salary, at approximately $1 million [Shaughnessy 2012], helping to make the US military the best equipped in the world; nonetheless, that soldier is still largely vulnerable to a fatal wound delivered by a single 25-cent bullet.

If humans will always be called upon to fight, then it makes sense to focus efforts on overcoming that frailty. To be sure, military training attempts to address these problems, but it can do only so much. Science and technology again offer hope for whatever challenges we may face, in this case to upgrade the basic human condition. We want our warfighters to be made stronger, more aware, more durable, more adaptive, and so on. The technologies that enable these abilities fall in the realm of human enhancement. As we explain in the following sections, human enhancement technologies are more than mere tools: we are drawing in these tools so close to our bodies that

they become internal to us or, for all practical purposes, integrated with ourselves—and this creates special competitive advantages and, sometimes, special risks.

This report examines risk, ethics, and policy issues arising out of military human enhancements—not necessarily a new class of war technologies but one that is now developing in novel ways. We first explain the purpose for this report, as well as more fully explain what we mean by "human enhancement"; then locate the ethical and policy issues, and survey key military enhancement technologies worldwide. Next, we consider existing legal and ethical norms as we build a new framework to evaluate human enhancement technologies in a military context. Finally, we suggest other areas of ethics research needed to help guide ongoing discussions in this emerging area of science and technology.

1.1 Purpose of Report

Technologies related to national security and defense tend to occur on the edges of innovation, but in so doing, they can raise novel and important ethical and policy issues. As quickly as such technologies advance today and make their way into the public sphere, their impact on society becomes even greater, making their study more urgent.

Human enhancement is one of these rapidly advancing fields. Enhancement technologies can profoundly affect not only the individual soldier and the face of war, but also society at large, particularly as military personnel integrate back into civilian life as veterans. Even before that, there may be integration issues as warfighters rotate out of active-duty deployment and into less-demanding activities, such as management and continuing education and training. Currently, there are approximately 23 million veterans in the US—or one out of every 10 adults—in addition to 3 million active and reserve personnel [US Census 2011]; therefore, the spillover effect alone into society may be significant, along with possible dual-uses of such technologies for civilian purposes.

Underlying technologies—such as neuroscience, biotechnology, nanotechnology, robotics, artificial intelligence, and more—offer the possibility of enhancing warfighters to help them complete missions safely and effectively. The US Defense Advanced Research Projects Agency (DARPA), for example, supports a host of research projects designed to build a warfighter that can learn better, eat grass, have super-vision, operate without sleep or food, swim like a dolphin, smell with the sensitivity of a dog's nose, and climb walls like a lizard, among other capabilities. (See section 2.4 for a more detailed survey of these projects.)

The enhancement goal of creating a super-soldier is not unusual: that is essentially what we are doing with military robots, but from an engineering or mechanical starting point rather than a biological one. Indeed, we are beginning to see a convergence in the two approaches where robotics and computer interfaces are integrated with the human body. And where the development and deployment of military robots give rise to ethical issues [Lin et al. 2008], the research and use of military human enhancements do as well.

While there is a substantial literature on ethical, legal, and psycho-social issues raised by similar enhancements, there is little discussion in the context of military use or about the specific programs mentioned above. For instance, there has been some work on stimulant drugs [Mehlman 2009b; Russo et al. 2008; Meijer 2007; Jaeger 2007; Kautz et al. 2007; Roedig 2007; Russo 2007; Schoolmaker 2007]; on ethical and legal issues in

the conduct of enhancement research on warfighters [Mehlman 2009a; Mehlman 2009b, Mehlman et al. 2010]; and on drugs that impair moral responsibility [Ashcroft 2008; Wolfendale 2008; Vincent 2012]. As another researcher in this emerging field, Jonathan Moreno recognizes the need for ethical analyses of military uses of neuro-enhancement, though he does not provide such an analysis himself [Moreno 2006]. Catherine and George Annas argue that soldiers should not be compelled to use enhancements but only do so voluntarily and with the advice of a physician who cannot be ordered to prescribe them [Annas and Annas 2009]. Only recently is research emerging on law and military enhancements generally [Parasidis 2012].

Outside of the military, the use of enhancements is highly controversial, but it is unclear how these objections would apply to the military context, e.g., whether they would be overcome by the special nature of military service and the exigencies of military operations, since enhancements potentially could enable warfighters to achieve their missions more safely, effectively, and economically. On the other hand, the military needs to tread carefully in this area: It is important to avoid causing unnecessary or excessive harm to warfighters by subjecting them to unethical experimentation or requiring them to use unjustifiably dangerous enhancement products. Enhancements could also cause harm to noncombatants, if enhanced warfighters behave in unintended, unethical ways. Furthermore, inappropriate decisions by the military could provoke a negative public reaction that would impair recruitment and the military's ability to fulfill its legitimate responsibilities.

This report, then, is the first to critically examine a broad range of existing and new concerns arising from military human enhancements, serving to fill the discussion gap. This gap is now visible given how important human enhancement research is potentially to both the military and broader society. The present lack of discussion, though, is perhaps understandable given the experimental nature of many of these innovations. However, some forms of enhancement are already being employed in the field, such as the alertness drug modafinil [Moreno 2006]. Moreover, enhancement technologies currently under study may soon reach the stage at which they would be considered for deployment.

With this report, we intend to help ethics, law, and policy—lagging behind, as is often the case—to catch up with science and technology. Consider, for instance, the explosion in number of robots in war: in its invasion of Iraq, the US had zero ground robots in 2003 and suddenly about 12,000 in 2008 [Singer 2009b, 61]; and its inventory of aerial robots multiplied by 40-fold between 2002 and 2010 [Gertler 2012, 2]. As public backlash today against the "drone wars" by the US demonstrates [Human Rights Watch 2012], it is imperative to start considering their impacts before technologies fully arrive on the scene and are deployed in the theater of war. With this report—and your participation in the discussion, as policymakers, scientists, academics, or just interested public citizens—we can better anticipate ethical, legal, and policy surprises, as well as avoid technology misuses that affect reputations and real lives.

1.2 Background

Since the beginning of human history, we have improved our minds through education, disciplined thinking, and meditation; and we have sought to improve our bodies with a sound diet, physical exercise, and training. But today, something seems to be different. With ongoing work in emerging

technologies, we are near the start of the Human Enhancement Revolution [Savulescu and Bostrom 2009; Allhoff et al. 2010a; Allhoff et al. 2010b].

We are no longer limited to "natural" methods to enhance ourselves or merely wielding tools such as hammers, binoculars, or smart phones. With drugs and devices, we are beginning to alter our biology and incorporate technology within our very bodies, and this seems to hold moral significance that we ought 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—as well as compelling uses for national security.

The issues arising from human enhancement technologies include those related to autonomy and freedom, health and safety, fairness and access, social disruption, and human dignity [Garreau 2006; Selgelid 2007; Allhoff et al. 2010a]. For instance, critics question whether technological enhancements translate into *happier* lives, which many see as the point of it all [President's Council on Bioethics 2003; Persaud 2006]. Of course, in a military context, general questions of human happiness are not explicitly addressed; rather, typical concerns are about accomplishing the mission and looking to the welfare of the troops, usually in that order. Insofar as context matters in making moral determinations here, the debate is made more complex with the need to account for the values and goods particular to the sphere under consideration [Murray 2007].

These concerns are driving the larger issue of whether and how society ought to regulate human enhancement technologies, which is closely related to how militaries ought to approach the same. For instance, 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]. 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 2002; Fukuyama 2006; Friends of the Earth 2006]. Still others recognize that society must adapt to new technological developments in this field [Hughes 2004; UK Academy of Medical Sciences 2012] and seek to strike a middle path between stringent regulation and individual liberty [Mehlman 1999, 2000, 2003, 2004, 2009a, 2009b; Juengst 2000; 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 losing our humanity [President's Council on Bioethics 2003; Sandel 2009]. And to the extent that the US military is usually on the cutting-edge of science and technology research—having given society such innovations as the Internet, global positioning system (GPS), radar, microwaves, and even the modern computer—this project will examine the associated ethical and policy issues at their root.

Military Interest in Enhancement

The use of human enhancement technologies by the military is not new. Under some definitions—but not necessarily ours, as we explain below—vaccinations would count as an enhancement of the human immune system, and this would place the first instance of military human enhancement at the United States' very first war, the American

Revolutionary War in 1775-1783: George Washington, as commander-in-chief of the Continental Army, ordered the vaccinations of American troops against smallpox, as the British Army was suspected of using the virus as a form of biological warfare [Fenn 2002]. At the time, the Americans largely were not exposed to smallpox in childhood and therefore had not built up immunity to the disease, as the British had. Biowarfare existed for centuries prior, e.g., in catapulting infected corpses to spread the plague in the Middle Ages [Cantor 2001; Lewis 2009].

More recently, and as a clearer instance of an enhancement, militaries worldwide have turned to amphetamines, though this trend is now shifting to new drugs. Amphetamines were used widely by American, German, British, and other forces in World War II, and again by the US in Korea [Stoil 1990]. Of course, milder and therefore less-controversial stimulants, such as caffeine in coffee and tea, have been used long before that.

Beginning in 1960, the US Air Force sanctioned amphetamines on a limited basis for the Strategic Air Command and, in 1962, for the Tactical Air Command. The US-Vietnam War sparked large-scale amphetamine use, such as by US Air Force and Navy pilots to extend their duty-day and increase vigilance while flying. According to one Cobra gunship pilot, "uppers" were available "like candy," with no control over how much was used [Cornum et al. 1997]. During the US invasion of Panama (Operation Just Cause), the drugs were administered in smaller doses under much more careful medical supervision; and in contrast to Vietnam, where pilots who used them frequently suffered from nervousness, loss of appetite, and inability to sleep, fewer side effects were reported during Operation Just Cause [Cornum et al. 1997].

The US Air Force continued to dispense "speed" during Operations Desert Shield and Desert Storm, or the first Gulf War. A survey of 464 fighter pilots in that conflict found that, during the six-week operation, 57 percent reported that they took Dexedrine (an amphetamine) at least once, with 58 percent reporting occasional use and 17 percent admitting to routine use; and 61 percent of users believed the drug was essential for completing their missions [Schlesinger 2003]. In 1991, the US Air Force Chief of Staff, General Merrill A. McPeak, banned the use of amphetamines because, in his words, "Jedi Knights don't need them" [Shanker and Duenwald 2003]. The ban lasted until 1996, when Chief of Staff John Jumper reversed the policy, as long-distance missions were being flown in Eastern Europe [Hart 2003].

In 2002, the US Air Force was dispensing 10 milligrams of amphetamines for every four hours of flying time for single-pilot fighter missions longer than eight hours and for two-pilot bomber missions longer than 12 hours. Asked why military pilots were permitted to use amphetamines when they were prohibited by commercial airlines, Colonel Peter Demitry, chief of the Air Force Surgeon General's Science and Technology division, explained, "When a civilian gets tired, the appropriate strategy is to land, then sleep. In combat operations when you're strapped to an ejection seat, you don't have the luxury to pull over" [Hart 2003].

Amphetamines became controversial in 2002 when four Canadian soldiers were killed and eight wounded in a friendly fire incident in Afghanistan. They were hit by a 500-pound laser-guided bomb dropped from a US Air Force F-16, the pilots of which were returning at 18,000 feet from a 10-hour mission and mistakenly thought they were attracting small-arms fire [St. Louis Post-Dispatch 2003, C12]. When they learned of their mistake,

the pilots claimed that they were jittery from taking Dexedrine for so many hours [Schlesinger 2003]. One of the pilots had been an instructor in the Illinois National Guard and had graduated from the Navy's Top Gun school. The fatalities were the first Canadians to die in combat since the Korean War [Simpson 2004].

Amphetamines continue to be approved for military use, however; a 2005 article by research scientists at the Air Force Research Laboratory states that "the US Air Force has authorized the use of dextroamphetamine in certain types of lengthy (i.e., 12 or more hours) single-seat and dual-seat flight missions. A recent NATO Research and Technology Organization publication discusses amphetamine's significant value as an anti-fatigue measure for aviation personnel" [Caldwell and Caldwell 2005].

In an effort to find a safer alternative to amphetamines, the military is reported to be turning to modafinil, a drug originally used to treat narcolepsy and which is sold under the brand name Provigil. According to Jonathan Moreno, US troops first used modafinil during the 2003 invasion of Iraq. The British press reports that the UK Ministry of Defence purchased 24,000 modafinil tablets in 2004 [Sample 2004].

Research has shown that the drug improves the performance of helicopter pilots in flight simulators [Caldwell, Caldwell, Smythe, and Hall 2000]. Moreno reports on a modafinil study that the Air Force's Office of Scientific Research conducted with 16 volunteers who, over a four-day period, stayed awake for 28 hours, then slept from 11 am until 7 pm: the modafinil group did significantly better on cognitive tests than subjects who took a placebo. Other research showed that modafinil-enabled pilots to remain alert for 40 hours, and experiments at Walter Reed Institute of Research have been carried out on soldiers who were sleep-deprived for as long as 85 hours [Sample 2004]. We discuss the moral and legal propriety of doing such research on the military later in this report. While the military is actively investigating new alertness drugs like modafinil, it continues to employ the old standby, caffeine. New US army "first strike" rations contain caffeine-laced chewing gum, with each stick providing the equivalent of a cup of strong coffee [Sample 2004].

In addition to using alertness drugs to enhance performance, a long-standing practice among members of the military has been to take dietary supplements. As reported in the journal *Military Medicine*, "a recent worldwide survey showed that over 60 percent of service members are regularly taking some type of dietary supplement. Usually, supplement use is at the advice of the sales clerk or by getting information from magazines or peers. Evidence-based information is rarely available or rarely translated into a form that can be properly used by the warfighter or their commander" [Jonas et al. 2010]. Despite the limited amount of scientific evidence, the military recognizes the potential value of supplements: "Nutritional supplements may indeed be beneficial in certain circumstances. For example, caffeine may provide advantages in military jobs and duties where attentiveness is necessary (e.g., aviators, sentry duty)" [Montain, Carvey, and Stephens 2010].

In 2008, Brookings Institution fellow Peter W. Singer reported an ambitious DARPA goal presented by DARPA program manager Michael Callahan at the agency's 50th anniversary conference in 2007: "making soldiers 'kill-proof'" [Singer 2009a]. Callahan described research that would enable soldiers "to bring to battle the same sort of capabilities that nature has given certain animals," including a sea lion's dive reflex; "products in the pipeline" such as "drugs that will boost muscles

and energy by a factor of 10, akin to steroids … on steroids," which Singer says "is jokingly termed the 'Energizer Bunny in Fatigues.'"; and a long-term $3 billion initiative entitled the "Metabolically Dominant Soldier," which bioethicist Jonathan Moreno claims is aimed at developing a super-nutritional pill that, in DARPA's words, would permit "continuous peak performance and cognitive function for 3 to 5 days, 24 hours per day, without the need for calories" [Moreno 2006]. A 2007 article in *Wired* identified extramural enhancement research projects sponsored by DARPA at the Dana-Farber Cancer Institute in Boston to develop substances to make soldiers more energetic; at Columbia University to enable soldiers to make do with less sleep; and in Ames, Iowa, where agricultural experts are researching bacteria that, once ingested, would enable soldiers to obtain nutritional value from normally indigestible substances such as cellulose [Shachtman 2007a, 2007c].

In 2008, JASON, a group of scientific advisors to the US Department of Defense (DoD), issued a report on "Human Performance" that discussed several types of biomedical enhancements, including the potential use of a class of compounds called ampakines to enhance cognition [JASON 2008]. A central point in the report was that the benefits from military enhancement were not similar to the benefits from performance enhancement in elite sports: "The consequences of gaining a small performance advantage, even if it is highly statistically significant, are likely quite different as regards force-on-force engagements than as regards Olympic competition. In brief, a small performance advantage in force-on-force should generally result in a *small* change in the outcome, while in Olympic competition it can result in a *large* change in the outcome" [JASON 2008, 15].

At the same time, the report acknowledged that a major change in human performance, giving as an example a reduction in the need for sleep, could have a "dramatic effect" on the "balance of military effectiveness" [JASON 2008, 37]. However, this dramatic effect would occur only if the adversary did not have access to the same benefit, leading the report to emphasize the need to monitor and be prepared to counter-enhancement use by potential adversaries.

Lately, the US military has extended its interest in performance enhancement to genetic technologies. In December 2010, JASON issued a report entitled "The $100 Genome: Implications for the DoD." The report outlined an ambitious plan to employ genomic technologies to "enhance medical status and improve treatment outcomes," enhance "health, readiness, and performance of military personnel," and "know the genetic identities of an adversary" [JASON 2010].

At the same time, the US military appears to be dead-set against the use of steroids. DoD Directive 1010.1, originally issued in 1984, states that "the illicit use of anabolic steroids by military members" is an offense under the Uniform Code of Military Justice [US Department of Defense 2012a].

The US military's current interest in biomedical enhancement is a logical corollary to its objective of maximizing the performance capabilities of its members. This performance imperative is reflected in the goals of military training. As an Army training manual states:

> War places a great premium upon the strength, stamina, agility, and coordination of the soldier because victory and his life are so often dependent upon them. To march long distances with full pack, weapons, and ammunition through rugged country and to fight effectively upon arriving at the area of combat; to drive fast-moving tanks and motor vehicles

> over rough terrain; to make assaults and to run and crawl for long distances; to jump into and out of foxholes, craters, and trenches, and over obstacles; to lift and carry heavy objects; to keep going for many hours without sleep or rest—all these activities of warfare and many others require superbly conditioned troops [Roy et al. 2010].

The recent interest in military performance optimization has led to expansions of the concept of warfighter fitness. In 2005, Army Field Manual 21-20 was replaced by Training Circular 3-22.20, "Physical Readiness Training (PRT)," which describes as its purpose "to develop a more agile, versatile, lethal, and survivable force—while preparing Soldiers and units for the physical challenges of fulfilling the mission in the face of a wide range of threats, in complex operational environments, and with emerging technologies" [Little 2010]. As the deputy commander of the US Army Training and Doctrine Command explained, "the youngest generation has grown up with energy drinks and soda while playing video games on the couch, instead of drinking milk and taking physical education classes in school …. The Army has seen a major increase in dental problems and bone injuries during basic training. In the last 15 years, average body fat has also increased to 30 percent in the South. … The challenge is taking young Soldiers entering the Army under these conditions and getting them ready to hump the Hindu Kush," the 500-mile mountain range between northwest Pakistan and eastern and central Afghanistan [Little 2010].

In 2006, a DoD conference titled "Human Performance Optimization" led to the creation of a dedicated human performance office within Force Health Protection in the Assistant Secretary of Defense Office (Health Affairs) [Land 2010]. The attendees at this conference recognized the need for a holistic "total force fitness" approach, which subsequently was adopted by the Army in 2008 under the name "Comprehensive Soldier Fitness Program." This program is described as signaling "the US Army's attempt to bring science to bear on a complex problem—shaping and accelerating human development and performance. The program is massive in scale and will directly impact three distinct populations—US Army soldiers, their family members, and civilians employed by the Army" [Lester, McBride, Bliese, and Adler 2011].

As these new training initiatives make clear, the goal is to go beyond preparation for the demands of military service and instead enable "functioning at a new optimal level to face new missions or challenges" [Jonas et al. 2010, 9]. Biomedical enhancement is one of the obvious technologies that might be employed in responding to this new performance imperative.

1.3 Questions

This report engages key issues related to military enhancements—from the other-regarding (issues about the impact on others) to self-regarding (issues about the impact on the enhanced individual)—and provides a framework to more fully evaluate them, including the following:

A. Law and Policy

- Could enhanced warfighters be considered to be "weapons" in themselves and therefore subject to regulation under the Laws of Armed Conflict (LOAC)? For instance, must militaries perform a legal review of enhancements as weapons, under Article 36 of the Geneva Conventions, Additional Protocol I? Or could an enhanced warfighter count as a "biological

agent" under the Biological and Toxin Weapons Convention (BTWC)?

- How would other LOAC apply to enhanced warfighters? For example, would a prohibition against torture apply equally to enhanced warfighters who can tolerate greater physical or mental abuse?
- How would enhanced warfighters be viewed by adversaries, and what effect would this have on mission success? For example, would enhanced warfighters be viewed as no longer "human," and therefore open to inhumane treatment?
- Would deployment of enhanced warfighters tend to lower the threshold for going to war, and does that violate the principle of last resort?
- How might adversaries attempt to negate the effects of enhancements?

B. Operations

- Would having enhanced and unenhanced warfighters together affect unit cohesion? Should enhancements be confined to a small, elite force or used more widely?
- Does being enhanced require a change either way in the length of a warfighter's service commitment? Is the ability to remain enhanced after leaving the service a legitimate recruiting incentive?
- How should being enhanced affect a warfighter's prospects of promotion, and how would this be viewed by others who are unenhanced?
- Would official restrictions on warfighter enhancements that are viewed as desirable by command or by the warfighters themselves lead to a black market, or further encourage use of private military contractors (PMCs) more willing to undergo risky enhancement?

C. Civil-Military Relations

- If the enhancements are not reversed, what effects will they have on the ability of the enhanced warfighter to make a successful return to civilian life? How can any adverse effects on the return to civilian life be minimized?
- What effect will this have on the US Department of Veteran Affairs (VA), insofar as enhancements will be regarded as service-connected?
- If there are enhancements available in the civilian market but not in the military, should warfighters be permitted to purchase and use them?
- What are the societal implications if/when military enhancements have a dual-use in civilian applications?
- Given the hostility toward the use of performance-enhancing substances in sports, would their use by the military provoke a negative public or political reaction that would undermine military recruitment, retention, or funding, or otherwise interfere with the mission of the military?

D. Ethics

- Should warfighters be required to give their informed consent to being enhanced, and if so, what should that process be?
- If a standard other than informed consent should be used, what additional protections are needed, and under what circumstances would they supersede a need for consent?
- Can a warfighter successfully object to being enhanced on religious or other grounds?
- Does the possibility that military enhancements will simply lead to a continuing arms race mean that it is unethical to even begin to research or employ them?

- Must the enhancements be reversible? If so, should they be reversed routinely upon discharge? Should the warfighter be able to refuse to have them reversed upon discharge?
- How should the use of enhancements be taken into consideration for purposes of commendation, promotion, and access to specialized training based on aptitude?

E. Safety and Risk

- Legally and ethically, how safe should these technologies be prior to their deployment? Should enhancements that pose longer-term risks be required to be reversible?
- Are there ethical, legal, psycho-social, or operational limits on the extent to which a warfighter may be enhanced as well as types of enhancement, e.g., enhancing mood to induce euphoria, fearlessness, or amnesia?
- Who gets to determine what constitutes an "acceptable risk" of a proposed enhancement?
- When can "military necessity," as determined by the chain of command, trump a different determination that an enhancement is unacceptably risky? Could enhancements jeopardize the chain of command?

Undoubtedly, there are other important questions arising from military human enhancements. Our goal here is not so much to directly answer each one—a satisfactory discussion of which is beyond the scope of this report—but to provide a framework to begin much-needed discussions about them.

2. What Is Enhancement?

To properly start, we need to offer a definition of "human enhancement", which has been elusive. Our definition follows that suggested by bioethicist Eric Juengst: an enhancement is a medical or biological intervention introduced into the body designed "to improve performance, appearance, or capability besides what is necessary to achieve, sustain or restore health" [Juengst 1998]. More will be said about this definition shortly.

In explaining what a human enhancement is and what it is not, we might start with ostensive definitions or illustrative examples, as we attempt to arrive at a principled distinction between the two. An enhancement, strictly speaking, is anything that improves our lives or helps us to achieve our goals, including the goal of survival. Thus, healthy foods, exercise, fire, tools such as a hammer, a roof over one's head, and so on are enhancements in at least the sense that they clearly enhance our lives or make them better.

Notice that these enhancements could also pose dangers, or a net loss in welfare, if used in certain ways: A diet could be fatal to a person who is allergic to its ingredients; exercise can lead to pulled muscles and more serious injuries; fire can burn down communities of homes; hammers can be turned to weapons; and a roof can fall on one's head in an earthquake. Indeed, it is difficult to imagine what exactly would count as an enhancement, if we were to insist that enhancements deliver only benefits.

But we do not mean "human enhancement" in this general sense. If we did, the notion would become so broad that it is rendered meaningless. Nearly everything we create could count as an enhancement, from Lego blocks to language itself, as long as we derive some benefit from it. Thus, if we are to use the term in a meaningful way—that is, to examine whether novel ethical issues arise from enhancements, as many intuitively suspect—we need to describe a limit to what counts as enhancements, and we need to defend that line, to the extent that there is no general consensus on a definition.

As such, we count the following as examples of human enhancement: an athlete who is stronger with anabolic steroids use; a student who earns higher grades by using Ritalin or modafinil to study more effectively; in the future, a soldier who can run for days on a drug that triggers in humans whatever metabolic processes enable an Arctic sled-dog to run for that long; and in the future, an office worker who is smarter than her peers, given a computer chip implanted in her head that gives instant access to databases and search engines.

In contrast, we do *not* count the following as examples of human enhancement: a muscular dystrophy patient who uses anabolic steroids to regain some strength; an expensive prep school background to enable a student to earn higher grades; a vehicle that can transport soldiers for days; a smartphone that enables a worker to check email and look up information.

But why should this be? Why are some technologies or applications considered as enhancements, while others that seem directed at the same goal are not? It is not enough that we offer a few examples of enhancements and nonenhancements; we need to explain the principle or reasoning for making this discrimination. If we are not aiming at the right targets to being with, our understanding of "human enhancement" would be arbitrary, and the ethical and policy analysis that follows could fail to be relevant or lack the desired force. To that end, we offer the following discussion.

2.1 Controversies

Any distinction that is meant to delimit enhancements instantly takes us down difficult philosophical rabbit-holes. This is why a definition of enhancement has been so elusive, and also why some commentators have denied that a definition can be found. To seriously consider the possibility that some enhancements raise novel ethical issues, though, let us assume that we can define enhancement, even if imperfectly, before we abandon hope for such a project. We will not explore this conceptual maze in much depth here, but only identify a few points of contention to convey a sense of how difficult it is to nail down a definition of enhancement:

A. Natural vs. Artificial

As a first approximation of a distinction between nonenhancements and enhancements, we may be tempted to look at the distinction between natural and unnatural (or artificial) [Bostrom and Sandberg 2009; Allhoff et al. 2010a]. That is, medical treatments for the sick, exercise, and education are "natural" activities that humans have been doing throughout history. Insofar as what is natural is good, these activities are not morally problematic. In contrast, drugs that give us the endurance of sled-dogs and other such enhancements take us beyond "natural" limits of human functioning. In that sense, enhancements are unnatural or artificial aids, and what is unnatural should evoke caution and skepticism—or so the distinction would seem to imply.

Never mind how such a distinction would be morally relevant, it quickly collapses upon reflection. In a general context, we might say that trees and rocks are natural in that they exist independently of human agency or intervention, while houses and computers are artificial in that they depend on our manipulation of materials. But many things we would consider to be natural depend on external manipulation, such as a bird's nest or a beaver's dam. If we then retreat and stipulate that external manipulation means *human* manipulation, then nothing created by humans can be considered to be natural. In other words, this move does not get us closer to what human enhancement is, if the definition tracks a natural-versus-artificial distinction: everything created by humans would then be artificial and an enhancement. As mentioned before, this notion seems unreasonably too broad; and it defies common intuitions that education and exercise—which involve printed books, microscopes, athletic shoes, and even high-priced Olympic coaches—are not enhancements but mere activities that benefit humans.

In the alternative, to the extent that humans arise from nature, there is a sense that everything we do is natural. But this conception suffers from being too broad in the opposite direction: nothing we do can be artificial, and so this too does not move us closer to understanding enhancement via the natural-versus-artificial distinction. Where we consider

mass education and high-tech exercise today to be natural, surely these would have been considered as unnatural at earlier times in human history, before the printing press, running-shoe technologies, and so on.

B. External vs. Internal

If the natural-versus-artificial distinction is untenable, then perhaps we can turn to another one: the distinction between an external tool or technology and an internal one [Garcia and Sandler 2008; Allhoff et al. 2010]. For instance, an Internet-enabled smartphone is a mere tool or something less than an enhancement, because it is external to our bodies; it could be held in one's hand, or placed inside a pocket, or connected to a wall charger. But a computer chip implanted in one's head, that delivers the same capabilities as the smartphone, is an enhancement; it is internal to one's body, and this delivers "always-on" or unprecedented access to the tool—and competitive advantage from its benefits—as compared to using it as an external device [Allhoff et al. 2010a; Lin 2010]. Likewise, athletic shoes are not properly enhancements, since they are external devices and not always worn, while anabolic steroids are enhancements because they are consumed or injected into the body.

"Internal" technologies could also be construed to include tools that are closely integrated to one's body, since that too delivers an "always-on" connectivity that does not exist with ordinary external tools. Bionic limbs that deliver super-strength, for instance, are not internal to a body, strictly speaking, yet we may consider them to be enhancements; they are attached to a body and become part of the person's identity, if that's important. Exoskeletons today, then, are mere tools, as they are bulky and cannot be easily worn for a long stretch of time; but if they were to become much more lightweight and unobtrusive, perhaps wearable like a shirt, then a case could be made for declaring them an enhancement.

The proximity of a device to the body can create a difference in degree that becomes a difference in kind. For instance, compare a person who looks up information on Google's search engine—on either his laptop or mobile device—to another person who looks up the same information through a "Google chip" implanted in her head. We would not say that the former is more knowledgeable or smarter for reciting information he found online; at best, he is resourceful. But while the latter may also just be reciting information she found online, her ability to do so at virtually any time—and seamlessly or transparently to others—would make her appear more knowledgeable, as if she were a savant who has uncanny recollection of facts and trivia (especially, say, in an exam room in which she is not supposed to have a computer).

Similarly, compare a person who uses Google Translate to communicate with the local population on his trip abroad to a person who has a Google translation chip implanted in her head to enable the same communication. The former would be recognized as someone who merely knows how to use a computer, while the latter could very well be mistaken as being fluent in the foreign language (again, say, in a test-taking environment). In other words, when it comes to proximity of a technological aid to the user, closer is generally better. We can thus defend the line between enhancement and mere tool in terms of internal versus external; and

closely held or worn tools are "internal" enough, if the user is rarely without them.[1]

A limitation to the external-versus-internal distinction, however, is that it cannot account for a dual-use technology that is internal-only. For instance, the distinction does not speak to any *prima facie* moral difference between anabolic steroids taken by a muscular dystrophy patient and the same drug taken by an Olympic athlete; they are both cases of a pharmacological intervention that is internal to the body. Many critics strongly believe that the former case is morally uncontroversial while the latter is not, and so our distinction ought to be able to sort those cases if possible, at least for further examination.

C. Enhancement vs. Therapy

A more capable distinction, then, could be that between therapy and enhancement [President's Council for Bioethics 2003; Allhoff et al. 2010a]. This distinction easily accounts for the case of anabolic steroids that was so difficult for the external-versus-internal distinction: a muscular dystrophy patient needs anabolic steroids for therapeutic value or medical necessity, while the athlete has more gratuitous and less urgent reasons. So the patient has greater moral justification for using the drug, and this maps to popular intuitions (in case they carry any weight) that therapeutic uses are permissible while athletic-performance enhancing uses are questionable.

By "therapy", we mean an intervention or treatment intended to alleviate a condition suffered by a patient, elevating his or health closer to normal. Of course, "normal" raises a host of questions itself, given the diversity of abilities across the species; for instance, Albert Einstein throws off the curve, as well as across one's own lifetime, e.g., health decreases with age. So if we may think of normal in terms of a species-typical range of functioning, that understanding may also need to be balanced against what is normal relative to one's own baseline and trajectory of health.

Thus, if a drug could give an average person the IQ of Einstein, and Einstein does not fall in the species-typical range but exceeds it, then use of the drug in this case is an enhancement and not therapy. However, if Einstein were still alive and suffered a brain injury that reduced his IQ, then his taking of the same drug is not an enhancement, because it serves to restore his abilities back to his normal or baseline level. Enhancement, then, is highly sensitive to context.

A more difficult case to reconcile involves vaccinations: are they an enhancement or therapy [Bostrom and Roache 2008; Allhoff et al. 2010a]? On one hand, the recipient is typically not sick when receiving the vaccination, so there's no immediate goal of restoring health to previous levels, as in most other cases of therapy. In this respect, a vaccination seems like an enhancement of one's immune system: it is not in the species-typical range of functioning that humans can naturally resist many pathogens. However, a vaccination could be considered to be preventative therapy: why

[1] We reserve discussion on whether the neurally enhanced person is in fact more knowledgeable or smarter, or if she even understands the information she is receiving. Insofar as human enhancement is a relational concept—i.e., it requires that the majority of a population is not enhanced—how a subject is perceived by others is relevant to the determination of whether she is enhanced or not.

should it matter if a therapeutic intervention—that is, designed to restore health back to normal—is administered before or after an illness?

For the purposes of this report, we will consider vaccinations to generally be a case of therapy, not enhancement, insofar as they aim to prevent a diseased condition. But we acknowledge that there may be nuances to this determination, which we lack the space to fully discuss here. For instance, perhaps it is reasonable to say that some therapies (such as vaccinations and accelerated healing) are also enhancements. Further, it may be pertinent whether a disease is caused by a naturally occurring pathogen or a completely engineered one; whether a disease can be caused by something other than biological agents, e.g., a chemical poison; and the related matter of how we define "disease." Again, context matters.

Notwithstanding difficult cases such as the above, the distinction between enhancement and therapy seems sensible, and so we will adopt it here as the primary heuristic or rule-of-thumb in identifying what is an enhancement and what is not. This distinction, though, is not binary and therefore may not always be sufficient; that is, what is not therapy might not automatically be an enhancement. For instance, the external-versus-internal distinction is still useful to explain why carrying a smartphone is morally permissible—neither therapy nor enhancement, but simply a tool—but integrating it with one's body is less obviously so, in that it may raise questions about safety, fairness, and other issues. (We discuss these issues in later sections.) Other distinctions may still be relevant, as fuzzy as they may be; for instance, notice that the concept of "natural" slips back into our analysis in the preceding paragraph, and we will return to it again shortly.

D. Enhancements vs. Disenhancements

If there can be human enhancements, then it also seems possible to have "disenhancements." An unenhanced person is simply one who is not enhanced, but a disenhanced person is one who undergoes an intervention that makes him or her worse off. This possibility speaks to our previous note that enhancements may pose dangers or lead to a net loss in welfare.

Although it may be difficult to envision the scenario in which a person would be disenhanced, we note that our livestock can be and sometimes are disenhanced. For instance, chickens sometimes have their beaks sheared off, so that they don't peck other chickens when jammed into confined spaces [Hester and Shea-Moore 2003]; and blind chicken are known to fare better in crowded environments, as they don't seem to mind as much as sighted birds [Thompson 2008]. Of course, this procedure may be an enhancement or benefit to us as the carnivorous consumer, but likely not a benefit from the chicken's perspective. On the other hand, it has been proposed that we ought to create blind chickens, because they don't seem to mind crowded conditions as much, and this is more plausibly a benefit to them [Thompson 2008].

For humans, removing some feature by itself is not automatically a disenhancement, if it delivers a benefit, especially for the subject. Today, for example, drugs are under development that can selectively target and erase memories [Lehrer 2012]. This would have beneficial uses, such as removing tragic memories that cause warfighters to have post-traumatic stress disorder (PTSD)

and rape victims to be unable to live normally without paralyzing fear. That is, their lives would be enhanced by the degradation of their memories. However, there may be more insidious uses of the same drugs that may count as true disenhancements that promise little to no benefit to the subject; for instance, we may threaten a terrorist with a drug that removes the memory of his family or life, if he does not reveal the information we want.

In bioethics, there are infamous cases of patients who want to amputate otherwise-healthy limbs [Dyer 2000; Ryan 2009], or deaf parents who want to select *in vitro* embryos that would lead to deaf babies [Dennis 2004]. From an outsider's perspective, this seems to be voluntary disenhancement and perhaps unethical. But from the patient's perspective, it is a case of therapy in that the limbs seem alien and are therefore unwanted. This and other cases, as well as the preceding ones, are also difficult cases in understanding what an enhancement is.

E. Enhancement vs. Engineering

The last distinction above suggests that more precise terminology may be needed here. Indeed, the US military appears to be shying away from the term "human enhancement" in favor of "performance optimization" and less evocative language; some of its past projects were called Metabolic Dominance and Peak Soldier Performance [Burnam-Fink 2011]. While we recognize that different terminology may be also suitable, we nonetheless will refer to the same technologies primarily as "human enhancements" for the following reasons:

First, they appear to be functionally equivalent: optimizing performance and enabling superior metabolism are both about enhancements to the human body; as we have defined enhancement, they are not meant to be therapeutic and are intended to exceed typical human limits. Second, "enhancement" is the primary language used by the ethics literature on the subject, and we would like our terminology to be consistent with that body of work, to avoid any confusion. Third, the military's apparent preference for "performance optimization" over "enhancement" could be viewed as a public-relations choice about avoiding the specter of ethical concerns that has been associated with human enhancements; in contrast, the very purpose of this report is to examine such ethical concerns. The perception is that "optimization", "peak performance", and similar phrasing do not immediately suggest the familiar charge of hubris that we are pushing science beyond what is natural or ethical—in this case, to create a superhuman.

But one person's Superman is another's Frankenstein's monster. This, then, raises another issue in terminology, that we perhaps ought to use the more neutral "human engineering" rather than value-laden "human enhancement" [Allhoff et al. 2010a]. That is, "enhancement" seems to imply a net benefit to the individual, for instance, resulting in increased endurance, greater concentration, or some other desired good desired. Yet it is often unclear whether the technologies we have used to improve aspects of ourselves truly deliver a net benefit, especially without long-term studies of such effects. For instance, anabolic steroids can help athletes gain strength, but they may also cause serious health conditions; therefore, if anabolic steroids can do more harm than good, then it seems premature to label them as enhancements as opposed to, say, poisons. Similarly, alcoholic drinks seem to deliver the benefit of enhancing one's mood, but too much can lead to a painful hangover, liver

damage, addiction, and so on, making it an open question of whether they are properly enhancers or not. As enhancements are usually context-specific and intended for a particular purpose, it may be misleading to discuss "enhancements" in general, absent some larger account of their role in human flourishing (e.g., see section 7.1).

Even less clear are the benefits and risks posed by emerging and speculative technologies that have not been studied nearly as much as alcohol, anabolic steroids, caffeine, and other familiar drugs. As rapidly advancing as modern science seems to be, there is still much that we do not know. But what we know for certain is that biological and neurological (as well as environmental or ecological) systems are highly complex and interconnected, making it very difficult for us to accurately predict the effects of any given drug or technological intervention in our bodies. In the face of that uncertainty, we should refer to such technologies as instances of human engineering, rather than enhancements—or so the argument goes.

Even so, this report will stay with the notion "human enhancement", with the understanding that the term does not necessarily imply a *net* benefit to the individual (much less to the larger society of which they are a part, especially given the likelihood of unintended consequences). Of course the term does signal a promise of delivering *some* benefit to the individual—otherwise why would we give a drug or apply a technology to a person, if we did not expect those benefits?—but we remain agnostic or neutral on the question of whether it results in an overall positive gain, all things considered. That open question is important to note but, for us, not at the expense of breaking from the traditional language of the ethics literature, especially since it is understood that human enhancements may raise significant ethical concerns, including health risks—and this is the point of examining the subject in the first place.

Again, we won't more fully explore the controversies here for space considerations, but they are important to acknowledge as we perform an ethical, legal, and policy analysis of human enhancements.

2.2 Working Definition

Given the preceding, we will operate under the working definition that **an enhancement is a medical or biological intervention to the body designed "to improve performance, appearance, or capability besides what is necessary to achieve, sustain or restore health"** [Juengst 1998].

By this definition, since an enhancement does not aim to prevent, treat, or mitigate the effects of a disease or disorder, a vaccination or immunization—even if it makes individuals' immune systems better than normal—would typically not qualify as an enhancement, as it merely aims to sustain health. Similarly, a drug to improve cognitive function in persons with below-normal cognitive ability ordinarily would not be considered an enhancement. But a pharmacological agent that improved their cognitive function to such a degree that the individual exceeded population-norms for cognitive functioning clearly would qualify as an enhancement. An intervention, such as caffeine and modafinil, also might be regarded as an enhancement if it improved the cognition of someone with normal cognition to start with, even though the resulting cognitive performance remained within population norms. Again, it seems relevant to also consider the baseline

state and potential of the subject, as difficult as they are to measure.

The concept of normality, as we mentioned, is itself elusive; what is "normal" for one population may be quite abnormal for another. If an average professional basketball player began to suffer from scoliosis and lost four inches from his current height, he would still be far taller than normal for an adult male human. And even within populations, the term retains some ambiguity. In some cases, normality refers to the frequency with which a trait or capability occurs within a population, presuming a normal distribution. In regard to height, the convention is to regard individuals who are more than two standard deviations below the mean height of the population as being of short stature [US Department of Health and Human Services 2008]. Such an approach may leave unresolved the dilemma between understanding normality as individual-relative versus population-relative, however; consider two eight-year old boys, both shorter than 98 percent of their peers. One's shortness is genetic; the other has parents of typical height but a glandular problem. Is giving a human-growth hormone (HGH) to them enhancement in both cases, therapy in both cases, or enhancement in one but therapy in the other?

To make things even more complicated, sometimes what is considered normal may have little to no relationship to the distribution of a trait. For example, normal eyesight is deemed to be 20/20, but only about 35 percent of adults have 20/20 vision without some form of correction [Johnson 2004]. Standards of normality also may vary from place to place and time to time, and can be expected to change as the use of enhancements increases. For example, body shapes that were considered healthy a hundred years ago are now considered obese; and the advertising and pharmaceutical industries are notorious for taking conditions heretofore taken as normal (such as body odor or discolored teeth) and presenting them as conditions requiring treatment. Furthermore, the concepts of disease and disorder themselves may be hard to pin down. Before 1973, the American Psychiatric Association regarded homosexuality as a mental disorder [American Psychiatric Association 2012]. The tendency seemingly only grows to regard increasingly more health-states as diseases and increasingly more interventions as treatments.

Insofar as enhancement is related to health, and health is related to normality, of course we would prefer that these concepts were all clearly defined. As a foundational notion, what is normal may still lack precision, so it may be tempting to discard the notion and therefore the interconnected chain of concepts. But there are good reasons to retain "normal" in our conceptual toolbox [Sparrow 2010], at least as a useful rule-of-thumb, even if imprecise.

In short, the distinction between health-oriented and enhancing interventions will not always be clear, and invariably there will be borderline cases. The difficulty of clearly identifying what counts as an enhancement complicates the task of determining the conditions, if any, in which it would be ethical to research or use enhancements in the military. Nevertheless, the above working definition is sufficient to allow us to draw some conclusions about the ethical and legal propriety of military enhancement.

2.3 Variables

A number of variables affect the analysis of the ethical and legal issues raised by military

enhancement. First is the matter of perspective: Obviously a primary perspective is that of the warfighter who is being asked to serve as a research subject or who is going to take the enhancement. There are different types of warfighters, with potentially different needs and concerns. Career enlistees presumably might be expected to care less about the impact of enhancements on their return to civilian life than enlistees who did not intend to make the military their career. Members of the Reserves and the National Guard might be legitimately concerned about whether an enhancement would be a boon or a handicap in their civilian jobs. Warfighters who engaged in direct combat might be more willing to take risky enhancements than service personnel or operators of drones and other remote weapons.

Special-operations personnel in particular are known to be risk-takers, including in the area of increasing their mission effectiveness, such as by intense training. This might make it necessary to protect them from voluntarily agreeing to take potentially dangerous enhancements. On the other hand, if these troops are sent on more dangerous missions than regular troops, their willingness to take greater risks to improve their performance would be understandable, and this could be grounds for treating them differently. However, caution should be exercised in policy choices that create class divisions—for instance, special treatment or different rewards—within a military, to the extent they cause dissension in the ranks.

Another perspective is that of the other members of the enhanced warfighter's unit, who will share to some degree in the benefits and burdens of the enhancement use.

A third perspective is that of the warfighter's superiors. There are a number of different types of superiors, each of whom has a somewhat different role and therefore a somewhat different viewpoint, including the immediate commander who is considering whether or not to give a warfighter an enhancement in the field; the officer in charge of a military research project who is considering whether to enroll a warfighter as a subject; military policy-makers deciding whether to embark on an enhancement research program; and the officers supervising enhancement research programs. The perspective of the warfighter's superior also will be affected if he or she is a physician or other type of health care professional, since health care professionals are subject to both military and professional normative regimes.

Finally, there is the perspective of third parties such as family members, members of military outside of the warfighter's unit, civilians with whom the warfighter interacts, the government, the public, and the nation. As we will see, a critical question is what should happen if these perspectives are in conflict, for example, if consideration of the welfare of the individual warfighter points the resolution of an ethical or legal issue in a different direction than the welfare of the unit, the military service, or the state.

A second variable that must be considered when addressing the ethical and legal concerns raised by military enhancements is the risk or other adverse consequences associated with their use. These may be physical or mental health risks, such as those sometimes attributed to anabolic steroids and other drugs, including addiction. In contrast to the US, for example, the Danish military does not give amphetamine to its combat troops; not only do the Danes question the

use of a drug that can impair judgment, but they are concerned about the potential for addiction [Nielsen 2007]. The degree of health risk may depend on whether the enhancement effect is permanent, long-term, or temporary, and on whether or not it can be reversed.

There may be adverse effects on third parties, such as family members who are impacted by the warfighter's adverse health effects, as well as harm to family and other relationships. One factor in terms of relational effects is likely to be how significantly the warfighter's characteristics are altered by the enhancement, and how perceptible the enhancements are. A radical change in someone's appearance or behavior could have serious social consequences, and the negative effects would be even greater if the change were so extreme that it provoked repugnance or horror.

Another harmful effect could be the reaction of adversaries. The more far-ranging the change brought about by the enhancement, the greater the risk that an adversary might view enhanced warfighters as no longer being really "human," and therefore treat them worse as prisoners. Adversaries also might use harmful methods to combat or reverse their enemy's enhancement effect.

A final element of risk is uncertainty. The less that is known about an enhancement, the less it has been properly studied, the more difficult it is to engage in the key ethical and legal process of balancing risks and benefits. At the same time, it is important to understand that no biomedical intervention is completely safe—all are accompanied by risks. A substance as safe as pure water can be deadly, as a Sacramento radio station learned when a participant died after drinking too much of it during a contest called "Hold your pee for a Wii," in which a Nintendo console was awarded to the person who could consume the most water without going to the bathroom [Nevius 2007]. The question is not how safe an intervention is but whether its risks are outweighed by its benefits. When the US Food and Drug Administration (FDA) approves a new drug or device as "safe," for example, what the agency really is saying is that it considers the health hazards of the product to be acceptable in view of the potential health benefits.

In the case of civilian medical care, for the most part the benefits that must be balanced against the risks are benefits that accrue to the patient. (The main exception is medical interventions to promote public health, about which more will be said in section 4.3.) But should warfighters be thought of primarily as private patients, or as defenders of society? If the latter, there are potential benefits of enhancement not only to the warfighter but also to the warfighter's unit, mission, service, and nation. One of the major challenges presented by military enhancement is determining how to balance the benefits to these third parties against the risk of harm to the warfighters themselves.

Another third variable is the legal status of the enhancement and the additional legal complexities that "military necessity" can create. Is the enhancement a drug, a medical device, or some other technology, such as a behavioral or psychological intervention? From a legal standpoint, these are subject to very different regulatory schemes, with drugs and devices governed by complex FDA rules and behavioral and psychological interventions essentially unregulated.

A product that the FDA has approved for enhancement use may be deemed to present fewer ethical concerns than a product that is

unapproved or still experimental, since approval bears on what is known about its safety and efficacy, as discussed later in connection with the administration of pyridostigmine bromide (PB), botulinum toxin (BT), and anthrax vaccine to combat troops during the Gulf War [Fitzpatrick and Zwanziger 2003].

Another important regulatory issue for enhancement drugs is whether they are controlled substances or otherwise illegal when used for non-medical, enhancement purposes. As noted earlier, the DoD prohibits the use of anabolic steroids by warfighters; accordingly, a commander who ordered her subordinates to take steroids would raise different ethical and legal concerns than one who ordered them to use a product that was not known for being subject to abuse, such as modafinil. Another variable is whether the enhancement product is supplied by the military or, like many dietary supplements, purchased privately by the warfighter. In the former case, the issue is whether warfighters need protection from their superiors; in the latter, the issue is whether the military ought to protect warfighters from their own poor choices.

A fourth variable that bears on ethical and legal issues is the type of characteristic or set of characteristics sought to be enhanced. For example, a drug that altered certain aspects of a person's mental state, such as mental acuity, personality, or emotions, might be deemed more problematic than a drug that increased strength or endurance, on the theory that the mental enhancement was more likely to affect the person's sense of self. The same would be true for a drug that altered or blocked a person's memory or reduced their capacity to make moral judgments, which have been raised as objections to the proposed prophylactic use of beta blockers such as propranolol to prevent post-traumatic stress disorder (PTSD) in combat troops [Henry et al. 2007; Wolfendale 2008]. Finally, one of the most important factors is whether warfighters are serving as human subjects in formal research projects, in which case the warfighters may be entitled to refuse to participate as human research subjects, or if instead the warfighters are given the enhancement to enable them to carry out their mission more successfully in the course of deployment, in which case a refusal to cooperate is likely to be viewed as disobeying an order. As we will see later, the experience during the Gulf War demonstrates that the distinction is not always clear.

2.4 Technology Survey

To help guide our discussion and ensure it is grounded in reality and not science fiction, we need to take a closer look at the human enhancement projects recently or currently pursued by militaries worldwide. Insomuch as the US military is the most transparent about its research projects as well as the most heavily invested, most but not all of our examples are projects based in US, drawn from open-source or unclassified information. These should provide a sufficient sense of the many kinds of human enhancement projects in progress, as we expect any foreign-based projects to be similar or at least not radically different.

This survey of projects can be presented in any number of sensible ways. We will conduct our brief visit through this landscape with the following taxonomy. These are not mutually exclusive categories, but they are meant to highlight key areas of focus and trends, sometimes overlapping: enhancements to (a) physical capabili-

ties, (b) cognitive capabilities, (c) the senses, and (d) metabolism. We will also survey (e) some dual-use research that could be used for enhancement, including relevant projects in basic science.

To be sure, many of these projects may not yet qualify as enhancements, as understood above. For instance, some are exoskeletons or other external equipment that are cumbersome or not yet of a size that can be closely and continually worn. But we include these in anticipation that such equipment could be scaled down and intimately connected with the human body that they would qualify as enhancements in the future. This anticipation is supported by current trends: we are seeing our everyday tools—computers, telephones, books, etc.—shrink and metamorphose into things that previous generations would not recognize, e.g., Google's digital glasses; and we are often reminded that the mobile phones we carry today have more processing power than the Apollo rockets that flew to the moon.

Other projects we discuss here are not so much devices as they are unusual training techniques, e.g., exploiting neuroscience and other technologies much more advanced than typical exercise equipment or teaching methods. These blur the line between mere "natural" training and more advanced methods that plausibly count as enhancements. We won't attempt to nail down a sharper definition than already provided above, and so we leave open the possibility that these and other projects may fall into the realm of enhancement, if not now then perhaps someday later.

Finally, the following is far from an exhaustive survey of projects but only a sampling of recent and current ones. Rather than a comprehensive catalog of all such projects, the purpose here is merely to have specific enhancements in mind as we continue a discussion about their ethical, legal, and policy implications, as well as to convey the ambitious range of enhancements that militaries are pursuing.

A. Physical capabilities

- Strength: Several research organizations are developing exoskeletons to increase human strength and endurance, e.g., ability to carry payloads of 200 pounds and to sustain a run at 7-10 miles per hour. These include Lockheed Martin's HULC, Raytheon's XOS, UC Berkeley's BLEEX, and other projects [UC Berkeley 2012; Lockheed Martin 2012]. Note again that anabolic steroids are prohibited by the US military as a method to enhance strength, unless prescribed by a physician [Ray 2012].

- Mobility: Similar to the above exoskeletons, other external devices can aid mobility. With military funding, University of West Florida researchers are developing an aquasuit that emulates the locomotion of dolphins, penguins and turtles [Sherer 2008]. In DARPA's Reconfigurable Structures program, the Z-Man is another bio-inspired project that is developing Geckskin, an adhesive fabric that can enable humans to climb walls like geckos, spiders, and other animals do [DARPA 2012g]. In the same program, robotics work is advancing, including a model with a running speed of a cheetah [DARPA 2012a, 155; DARPA 2012c]. From Germany, the Gryphon wingsuit reimagines the parachute as a wearable and powered glider system [Fallon 2009].

- Protection: Body armor, from medieval to

modern times, are not enhancements but mere tools, by our understanding of "enhancement." But again, as tools are closely held and integrated with the body, this determination becomes debatable. Researchers at BAE Systems and MIT's Institute for Soldier Nanotechnologies are working on liquid armor as well as dynamic, flexible fabric that can stiffen into armor (or a splint, etc.) when needed [BAE 2012a; MIT 2005].

- Virtual capabilities: Perhaps the greatest protection against harm on the battlefield is to not be on the battlefield at all. Militaries use drones, missiles, and other weapons for this and other compelling benefits [Shane 2012]. These tools do not replace the human warfighter—they are not true proxies—but other projects may. Similar to the Hollywood movie of the same name, DARPA's Avatar program seeks to "develop interfaces and algorithms to enable a soldier to effectively partner with a semi-autonomous bi-pedal machine and allow it to act as the soldier's surrogate" [DARPA 2012a, 123]. Relatedly, DARPA's Bits to Behavior via Brains (B3) program is investigating how virtual-world activities impact real-world neural mechanisms [DARPA 2012a, 45].

B. Cognitive capabilities

- Awareness: Related to virtual capabilities is the need for greater situational awareness, e.g., better communication, data integration from different sources, threat identification, coordinated efforts, and so on. The Future Combat Systems program had sought to develop an ambitiously networked and multi-purpose battlesuit, the Future Force Warrior suit [Hanlon 2004]; while that program was cancelled in 2009, the idea lives on in other projects. DARPA's Cognitive Technology Threat Warning System (CT2WS) is a computer-assisted visual aid that instantly identifies threats that warfighters might only subconsciously see, given that only a fraction of our visual data is consciously registered [DARPA 2012a, 168]; and the agency's Soldier Centric Imaging via Computational Cameras (SCENICC) seeks to develop electronic contact lenses that do similar work [DARPA 2012f]. (DARPA's Neovision2 is a related project in computer vision, though designed to be mounted on vehicles, not to enhance human visual processing [DARPA 2012a, 169].)

- Attention: Caffeine has been long used as an attention stimulant, especially in war. In the American Civil War, the Union had cut off supply lines to coffee and tea to strategically deprive the South of caffeine [Brecher 1972]. In modern warfare, pilots and other combatants use amphetamines—sometimes called "go pills" by the US military—to increase focus, though to possible serious side-effects [Emonson and Vanderbeek 1995]. As a safer alternative, the US and other militaries are using or exploring the use of modafinil and other drugs, which are already used illicitly to enhance academic and workplace performance [Caldwell et al. 1999].

- Memory: Where DARPA's Human Assisted Neural Devices program seeks to strengthen and restore memories [DARPA 2012a, 50], other research aims to produce drugs and treatments that can erase memories, e.g., horrific ones that cause post-traumatic stress disorder (PTSD) [Lehrer 2012].

- **Planning**: Artificial intelligence is enhancing decision-making and planning. DARPA's "Deep Green automatically infers the commander's intent and produces a plan from the commander's hand-drawn sketches to facilitate rapid option creation, and plan recognition and understanding capabilities ensure the commander's intent is fully represented in the system" [DARPA 2012a, 246].

- **Learning**: Learning that surpasses results from traditional methods may perhaps count as an enhancement, especially new techniques that exploit advances in neuroscience and cognitive psychology. This is the goal of several research programs at DARPA, such as: Neurotechnology for Intelligence Analysts, Accelerated Learning, Education Dominance, Augmented Cognition, and Training Superiority programs [DARPA 2012a, 163].

- **Language**: Real-time language translation would bridge a major communications gap with foreign-language speakers; this is the goal of DARPA's Boundless Operational Language Translation (BOLT), Robust Automatic Translation of Speech (RATS), TRANSTAC, and other programs [DARPA 2012a, 87]. Today, there's even mobile software for that, DARPA's TransTalk app [Pierce 2011]; and Google offers a consumer version with its Translate app, as well as potentially for its Project Glass, an augmented-reality digital display that is worn like eyeglasses [Gilbert 2012].

- **Communication**: DARPA's Joint Tactical Air Controller (JTAC; formerly, Joint Terminal Attack Controller), or hologram goggles, also resembles eyeglasses but, instead of language translations, facilitates direct communication between pilot and aircraft [DARPA 2012a, 205]. In the UK, BAE Systems' Q-Sight is a flight helmet that enhances situational awareness as well as control of the aircraft, including targeting through eye movements [BAE 2012b]. Some projects seek to enable communication through thought alone, such as the brain-computer interface work—or "synthetic telepathy"—funded by the US Army Research Office, in collaboration with University of California at Irvine, Carnegie Mellon University, and University of Maryland [Bland 2008].

C. Human senses

To add more nuance and details to this survey of enhancement projects, we can also consider cognitive-related projects as enhancements to particular senses; as such, they all increase situational awareness.

- **Sight**: DARPA's Functional Materials program aims to develop telescoping contact lenses [DARPA 2012a, 156]. We already mentioned DARPA's CT2WS, as well as the Google's Project Glass; the latter is not funded or related to military applications, but it may have dual-use applications (see below).

- **Smell**: Chemical sensors are increasingly important, since they can detect explosives and other materials. DARPA's RealNose project, for instance, seeks to mimic a dog's sense of smell (olfactory system) for "greater sensitivity to a wide range of new and old chemical agents and will serve to protect troops and infrastructure" [DARPA 2012h].

- Hearing: Defence Research and Development Canada seeks to develop an electronic pass-through hearing protection (EPHP) that filters out environmental noises while enhancing verbal signals [Burrell and Abel 2009]. In Scotland, similar projects aim to enhance acoustic speech with cochlear implants. Scientists in China, too, are working on technologies to enhance speech [Shao and Chang 2007].

- Touch: Defence Research and Development Canada is also developing a tactile cueing system for pilots to detect motion without visual or auditory cues [Bouak, Kline, and Cheung 2011]. Apart from military research, citizen-scientists and artists have been experimenting with magnetic implants in their bodies to detect electromagnetic fields, such as those created by electronic devices [Popper 2012; Ungerleider 2012; Cole 2012]; these are potentially dual-use technologies as well (see below).

- Taste: Insofar as smell is closely related to taste, enhancements to the olfactory system (smell) could be considered as enhancements to the gustatory system (taste). "Electronic tongues" can identify flavors, bitterness, spiciness, saltiness, sweetness, and other tastes. Moreover, the US military is interested in using the human tongue to sense or "see" the surrounding environment, as sonars can, for 360-degree "vision" even at night [Associated Press 2006].

D. Human metabolism

To add more nuance and details to this survey of enhancement projects, we can also consider physical- and cognitive-boosting projects as metabolic enhancements, in case the distinction is relevant.

- Endurance: DARPA's Metabolic Dominance program—later called Peak Soldier Performance—includes many umbrella goals, one of which is to boost human endurance, both physical and cognitive [Shachtman 2007c]. Stanford researchers, for instance, have developed CoreControl, a glove that regulates body temperature to enhance resistance to heat and cold, thus increasing endurance and preventing the associated loss of cognitive functions [Shachtman 2007a]. Dietary supplements, such as quercetin, are also being investigated for cognitive-enhancing effects under stress [Priprem et al. 2008].

- Food: Relatedly, US and UK scientists are researching genetic and cellular (mitochondrial) enhancements to enable soldiers to run for long distances and to survive longer without food, e.g., as Alaskan sled dogs are able [Alexander 2010]. As a substitute for human food, DARPA's Crystalline Cellulose Conversion to Glucose (C3G) program could someday enable warfighters to eat otherwise indigestible materials, such as grass [DARPA 2012i].

- Sleep: Besides the basic need for food, our need for sleep is a severe limiting factor in battlefield performance; and this is why alertness drugs are much sought after. DARPA-funded researchers are also investigating light and magnetic therapies to safely maintain wakefulness [Shachtman 2007b]. Nature already provides proofs-of-concept that mammals can operate without much sleep: whales and dolphins would drown if they were to truly sleep, but instead

only half of their brains sleeps at a time [Hecker 1998]; and giraffes reportedly need less than two hours of sleep a day, taking highly efficient "power naps" throughout the day [Tobler and Schwierin 1996].

- Health: Though we had defined enhancement as more than restoring health, some technologies or treatments that accelerate healing are arguably enhancements, given the speed of regeneration [Wang 2008]. That is, a difference of degree may become a difference in kind. Other research aims at blocking pain [Wang 2008].

E. Dual-use research

The following is a sample list of military-funded research projects in therapeutics or healing, but they may also have dual-use applications as enhancements. The basic-science projects we include here also could have either therapeutic or enhancement uses, or both.

- Stress: Enabling Stress Resistance; Neuroscience Technologies; Detection and Computational Analysis of Psychological Signals (DCAPS; formerly called Healing Heroes); US Army's investigation of selective serotonin reuptake inhibitors (SSRI) as treatment for PTSD [McKeon et al. 2009; DARPA 2012d; DARPA 2012a, 63].

- Circulatory: Blood Pharming; Tactical Biomedical Technologies [DARPA 2012a, 165, 169].

- Metabolism: Metabolic Flexibility and Suspended Animation, e.g., hibernation [Roth Lab 2012].

- Environmental: Maintaining Combat Performance; Warrior Web; Rapid Altitude and Hypoxia Acclimation (RAHA) [DARPA 2012a, 162; DARPA 2012e]; thermotolerance research by US Army and others [Carter and Calais 2009].

- Toxins and radiation: US Army's protective bioscavenger research (human serum butyrylcholinesterase) [Saxena et al. 2009]; radioresistance research by Bulgaria's Military Medical Academy and others [Kindekov et al. 2009].

- Prosthetics: Revolutionizing Prosthetics; Reliable Neural Interface Technology (RENET) [DARPA 2012a, 171].

- Diagnostics: Autonomous Diagnostics to Enable Prevention and Therapeutics (ADEPT; formerly part of Synthetic Biology) [DARPA 2012a, 45; 2012c]; HEADS helmet research by UK's BAE Systems [BAE 2012c].

- Drug delivery system: Feedback Regulated Automatic Molecular Release (FRAMR) [DARPA 2012j].

- Basic science: BioChronicity; Unconventional Therapeutics; In Vivo Nanoplatforms; Biological Adaptation, Assembly and Manufacturing; BioDesign; Living Foundries [DARPA 2012b; DARPA 2012a, 196, 4, 165, 166].

- Non-military: Not all research projects related to human enhancement are funded by the military, though many are. For instance, we mentioned Google's Project Glass previously, as well as citizen-scientists and artists—i.e., "biohackers"—who conduct their own enhancement research, often on their own bodies. Life-extension is a major

area of civilian enhancement research [de Grey and Rae 2007], though surprisingly we have not seen the military take much interest here. As such, we do not engage a suite of ethical questions related to the quest for longer life [Williams 1973; Garreau 2006; Harris 2007; Allhoff et al. 2010a].

3. Law and Policy

With that background, we begin with a discussion of the primary legal issues—in both international law and US domestic law—that are relevant to military enhancements, as well as possible implications on military operations. To the extent that ethics underwrites law and policy, we can better understand the former by looking at the latter as the real-world implementation of ethics. In later sections, we will focus more on an ethical analysis, as distinct from a legal one.

3.1 International Law

What are the provisions in international law that may bear upon military human enhancements? Should enhancement technologies, which typically do not directly interact with anyone other than the human subject, be subject nevertheless to a weapons legal-review? That is, is there a sense in which enhancements could be considered as "weapons" and therefore subject to legal instruments such as the Biological and Toxin Weapons Convention? How do norms related to human-subject research and medical ethics impact military enhancements?

These are some of the most important questions for military enhancements as they relate to international law [Lin 2012a]. Conceptually, we will divide international law into two categories: the first is international humanitarian law (IHL), also known as the laws of armed conflict (LOAC), and the second is composed of international agreements related to biomedical research. Because these are well-discussed conventions, we will only list them here and discuss them later in more detail as needed. [2]

Under IHL, the main instruments of interest here are:

- Hague Conventions (1899 and 1907)
- Geneva Conventions (1949 and Additional Protocols I, II, and III)
- Biological and Toxin Weapons Convention (1972)
- Chemical Weapons Convention (1993)
- Rome Statute of the International Criminal Court (1998)

Under international biomedical laws—which we discuss more in the next section—the main instruments of interest here are:

- Nuremberg Code (1947)
- Declaration of Geneva (1948)
- Declaration of Helsinki (1964)

As it concerns new technologies, Article 36 of the Geneva Conventions, Additional Protocol I, specifies that:

> In the study, development, acquisition or adoption of a new weapon, means or method of warfare, a High Contracting Party

[2] Though not a signatory to some of these conventions, the US nevertheless has an interest to stay within international norms, e.g., to not trigger international condemnation.

> is under an obligation to determine whether its employment would, in some or all circumstances, be prohibited by this Protocol or by any other rule of international law applicable to the High Contracting Party [1977].

But does Article 36 apply to human enhancement technologies? That is, should they be considered as a "weapon" or "means or method of warfare" in the first place? Unlike other weapons contemplated by IHL, enhancements usually do not directly harm others, so it is not obvious that Article 36 of Additional Protocol I would apply here. If anyone's safety is immediately at risk, it would seem to be that of the individual warfighter, thereby turning the debate into one about bioethics. To that extent, warfighters, whether enhanced or not, are not weapons as typically understood.

Yet in a broader sense, the warfighter is not only a weapon but perhaps a military's best and oldest weapon. Warfighters carry out missions, they sometimes kill enemies, and they represent one of the largest expenditures or investments of a military. They have cognitive and physical capabilities that no other technology currently has, and this can make them ethical, lethal, and versatile. The human fighter, engaged in hand-to-hand combat, would be the last remaining weapon when all others have been exhausted. So in this basic sense, the warfighter is undeniably a weapon or instrument of war.

Still, should Article 36 be interpreted to include warfighters themselves as weapons subject to regulation? There could be several reasons to think so. First, other organisms are plausibly weapons subject to an Article 36 review. Throughout history, humans have employed animals in the service of war, such as dogs, elephants, pigeons, sea lions, dolphins, and possibly rhinoceroses [Knights 2007; Beckhusen 2012; US Navy 2012]. Dogs, as the most commonly used animal, undergo rigorous training, validation, and inspections [US Department of the Army 2005]. If a military were to field a weaponized rhino in an urban battlefield that contains innocent civilians, we would be reasonably worried that the war-rhino does not comply with Article 36, if rhinos cannot reliably discriminate friends from foe, e.g., a rhino may target and charge a noncombatant child in violation of the principle of distinction. A similar charge would apply to autonomous robots in such a general environment in which distinction is important, as opposed to a "kill box" or area of such fierce fighting that all noncombatants can be presumed to have fled [Lin et al. 2008].

If autonomous robots are clearly regulatable weapons, then consider the spectrum of cyborgs—part-human, part-machine—that exists between robots and unenhanced humans. Replacing one body part, say a human knee, with a robotic part starts us on the cybernetic path. And as other body parts are replaced, the organism becomes less human and more robotic. Finally, after (hypothetically) replacing every body part, including the brain, the organism is entirely robotic with no trace of the original human. If we want to say that robots are weapons but humans are not, then we would be challenged to identify the point on that spectrum at which the human becomes a robot or a weapon.

The inability to draw such a line may not be a fatal blow to the claim that humans should be treated as weapons; after all, we cannot draw a precise line at which a man who is losing his hair becomes "bald", yet there's clearly a difference between a bald man and one who has a head full of hair [Stanford 2011]. But a simpler solution

may be to say that humans are weapons, especially given the reasons offered previously.

As it applies to military enhancements, integrated robotics may be one form of enhancement, but we can also consider scenarios involving biomedical enhancements such as pharmaceuticals and genetic engineering. Again, on one end of the spectrum would stand a normal, unenhanced human. One step toward the path of being fully enhanced may be a warfighter who drinks coffee or pops amphetamines ("go pills") as a cognitive stimulant or enhancer. Another step may be taking drugs that increase strength, erase fear, or eliminate the need for sleep. At the far, more radical end may be a warfighter so enhanced that s/he no longer resembles a human being, such as a creature with four muscular arms, fangs, fur, and other animal-like features. If a war-rhino should be subject to Article 36, then so should this radically enhanced human animal, so it would seem. And to avoid the difficult question of drawing the line at which the enhanced human becomes a weapon, a more intuitive position would be that the human animal is a weapon all along, at every point in the spectrum, especially given the previous reasons that are independent of this demarcation problem.

If we agree that enhanced human warfighters could properly be weapons subject to Article 36, what are the implications? Historically, new weapons and tactics needed to conform to at least the following:

- Principle of distinction
- Principle of proportionality
- Prohibition on superfluous injury or unnecessary suffering (SIrUS)

To explain, first, the principle of distinction demands that a weapon must be discriminating enough to target only combatants and never noncombatants [Geneva Additional Protocol I 1977; Sassòli 2003]. Biological weapons and most anti-personnel landmines, then, are indiscriminate and therefore illegal in that they cannot distinguish whether they are about to infect or blow up a small child versus an enemy combatant. Unintended killings of noncombatants—or "collateral damage"—may be permissible, but not their deliberate targeting; but to the extent that biological weapons today target anyone, they also target everyone. (If they don't target anyone in particular but still kill people, then immediately they would seem to be indiscriminate.) However, a future biological weapon, e.g., a virus that attacks only blue-eyed people or a certain DNA signature [Hessel et al. 2012], may be discriminate and therefore would not violate this principle (but it could violate others).

Second, the principle of proportionality demands that the use of a weapon be proportional to the military objective, so to keep civilian casualties to a minimum [Geneva Additional Protocol I 1977; Cohen 2010]. For instance, dropping a nuclear bomb to kill a hidden sniper would be a disproportionate use of force, since other less drastic methods could have been used.

Third, the SIrUS principle is related to proportionality in that it requires methods of attack to be minimally harmful in rendering a warfighter *hors de combat* or unable to fight [Coupland and Herby 1999]. This prohibition has led to the ban of such weapons as poison, exploding bullets, and blinding lasers, which cause more injury or suffering than needed to neutralize a combatant.

However implausible, we can imagine a human enhancement that violates these and other provisions—for instance, a hypothetical "berserker" drug would likely be illegal if it causes the warfighter to be inhumanely vicious, aggressive, and indiscriminate in his attacks, potentially killing children. (For the moment, we will put aside enhancements that are directed at adversaries, such as a mood-enhancing gas to pacify a riotous crowd and a truth-enhancing serum used in interrogations; the former would be prohibited outright by the Chemical Weapons Convention in warfare [The Royal Society 2012], partly because it is indiscriminate, and the latter may be prohibited by laws against torturing and mistreating prisoners of war.) The point here is that it is theoretically possible, even if unlikely, for a human enhancement to be in clear violation of IHL.

But let us assume that the human enhancement technologies generally conform to these basic principles. (If they do not, then there's already strong *prima facie* reason to reject those technologies as unlawful under IHL; those are the easy cases that do not need to be examined here.) Given this assumption, are there other, less-obvious international laws that could prohibit military enhancements? We will discuss three possible areas of concern:

A. Biological Weapons

First, the opening discussion of this report's section on whether enhancements are weapons is relevant not only to Article 36 of Additional Protocol I but also arguably to the Biological and Toxin Weapons Convention (BTWC). The first article of the BTWC states that:

> Each State Party to this Convention undertakes never in any circumstances to develop, produce, stockpile or otherwise acquire or retain: (1) microbial or **other biological agents**, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes; (2) weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict [1972; emphasis added].

Whether or not they are properly weapons, are military human enhancements "biological agents" in any reasonable sense? The BTWC is silent on this question, though it does anticipate unforeseen developments in genetic engineering, biotechnology, synthetic biology, and other scientific fields [BTWC 1972, Additional Understandings of Article I]. The usual assumption is that these "agents" are both limited to roughly being microbial in size and to biological substances that are directed at adversaries, not directed to the enhancement of one's own military personnel. This assumption, unfortunately, is not explicit enough in the BTWC; that is, it does not define what a biological agent is. As a result, it is still an open question of whether the BTWC applies to human enhancement technologies.

To answer this open question, let's try to better understand what a "biological agent" is. This seems to mean an agent that is biological in nature (e.g., anthrax virus), as opposed to purely chemical (e.g., chlorine gas) or physical (e.g., a falling object); and an agent is a substance or actor employed for some effect or purpose (e.g., LSD is a psychotropic agent). But in a broader but consistent sense, agents can be persons too (e.g., a government spy is a "secret agent"). If so, then enhanced warfighters can be agents. Even if we reject this understanding and stipulate

that biological agents must be nonperson substances—an interpretation that is not explicit in the BTWC—we can still consider the enhancement technology itself as an agent, apart from the warfighter it enhances.

Again, insofar as the BTWC does not specify that biological agents must be of the kind that directly harms adversaries, then some human enhancements—such as anabolic steroids for increased strength—would seem to count as biological agents: they are substances employed for some effect and are biological in nature. They would serve "hostile purposes" in that they create a warfighter more capable of defeating adversaries and fulfilling military missions; so these enhancements would at least indirectly harm others.

With respect to scale, it is difficult to see why size would matter for the BTWC, which again is not explicit on the issue. If we understand the BTWC to be interested in only microbial-sized agents—and returning to the position that humans can be agents—then consider a hypothetical process that can shrink a human soldier to the size of bacteria, such as in the theatrical film *Fantastic Voyage* [Shickel 1966; Internet Movie Database 2012]: if size matters, then the BTWC would seek to regulate the microscopic soldier, but not the full-sized soldier who has the exact same capabilities. Why the difference in concern here? It may be that the microscopic soldier can be stealthier, infiltrate more places, and so on, but none of these concerns is cited in the BTWC as a motivating reason for regulation.

Related to enhancements, the BTWC arguably would have something to say about bioengineered insects and animals, for instance, that are used as weapons. Like pathogens, insects and most animals do not obey human orders and would therefore be unpredictable and indiscriminate as a weapon; and tiny attack-insects do not seem significantly different in kind than microscopic organisms also designed for attack. One possible difference is that microorganisms typically harm us from the inside-out, and somehow this could be less humane and more frightening than biting us or attacking our bodies from outside-in. Yet we can also envision bioengineered animals that operate from the inside-out too, as tapeworms and mosquitoes do (at least the disease they transmit into our bloodstreams). So if it's not unreasonable to think that bioengineered insects would be subject to the BTWC, then size does not matter for the BTWC, or at least the interest is not limited to microscopic organisms.

As for other qualifiers in the BTWC, some enhancements could be noncompliant in that they have no "prophylactic, protective or other peaceful purposes" [BTWC 1972, Article I.1]. A hypothetical berserker drug could be an example: its only obvious function is to make a person a fiercer, rampaging combatant. This is to say that, under some plausible understanding of the BTWC, at least some possible warfighter enhancements could count as "biological agents" and therefore subject to the BTWC. If the BTWC intends or ought to rule out enhancements under its purview, then its language needs to be made more explicit.

B. Inhumane Weapons

Contributing to the above problem with the BTWC—i.e., what counts as a "biological agent"—is also a lack of specificity on the motivating reasons for the BTWC in the first place. That is, the convention is unclear on *why* we should want to prohibit biological and toxin weapons. But there are some clues. In the

preamble to the BTWC, state parties to the convention declare they are:

> Convinced of the importance and urgency of eliminating from the arsenals of States, through effective measures, such dangerous **weapons of mass destruction** as those using chemical or bacteriological (biological) agents…
>
> Convinced that such use would be **repugnant to the conscience of mankind** and that no effort should be spared to minimize this risk [1972; emphasis added].

That is, biological agents, such as highly infectious bacteria or viruses, are difficult to control in their propagation and therefore are indiscriminate to use as a weapon. Anthrax spores, for instance, may be carried by the wind and can infect a child or entire populations just as easily and likely as a soldier. This would be a clear violation of the principle of distinction in IHL.

If this were the only motivating reason for the BTWC, then perhaps we can conclude that human enhancements are not the biological agents that the convention intends to address; enhancements are generally not infectious or "weapons of mass destruction." But this cannot be the only reason. In its categorical prohibition of biological and toxic weapons, the BTWC does not distinguish between infectious and non-infectious ones. For instance, a poison dart that can be used only once in a precisely targeted attack would still be banned, even though it is not a weapon of mass destruction, given that it is a toxin and especially if there were no "prophylactic, protective or other peaceful purposes" for the poison.

To explain why the prohibition is categorical, we can examine the next clue, that the BTWC is motivated by "the conscience" of humanity. That is, some methods of killing are more insidious and repugnant than others. Biological and toxin weapons, then, are of special concern, because they are usually silent, invisible, and indiscriminate ways of killing people—often with horrific, painful medical symptoms over the course of several days or weeks.

But is any of this relevant to human enhancements? Again, enhancements usually do not directly harm others, much less kill people in "repugnant" ways. Even if we say that enhancements indirectly harm others, they do not typically do so in ways more repugnant than conventional means, since an enhanced warfighter is still bound by IHL to never use certain weapons and tactics against adversaries.

Like the "weapons of mass destruction" clue, that a biological agent is "repugnant to the conscience of mankind" also does not seem to be a necessary requirement, just a sufficient one. Consider that some poisons or pathogens may kill quickly and painlessly, such as those administered in death-penalty executions: they seem to be much more humane than conventional means, such as shooting bullets and dropping bombs that render an adversary *hors de combat* through massive, bloody injury to human bodies and brains. Nevertheless, these "clean" poisons are prohibited by the BTWC and elsewhere, such as the Hague Conventions. So, even if human enhancements are not repugnant in the same ways that anthrax or arsenic may be, and even if they are not weapons of mass destructions, they could still fall under the authority of the BTWC, again since the convention is not explicit on its motivating reasons.

In any event, enhancements could be repugnant in different ways. We previously mentioned the possibility of creating a "berserker" drug, as well as a warfighter so enhanced that s/he no longer resembles a human being, such as a creature with four muscular arms, fangs, fur, and other animal-like features. If this sounds far-fetched, we need only look at the history of warfare to see that intimidating adversaries is a usual part of warfare. From fierce Viking helmets, to samurai armor designed to resemble demons, to tigers and sharks painted onto warplanes, to ominous names for drones such as "Predator" and "Reaper", scaring adversaries can demoralize and make them easier to defeat. This suggests that it may not be so irrational nor inconsistent with customary practices to design enhancements to be inhuman and therefore perhaps inhumane.

Further, biomedical research is presently ongoing with "chimeras", or animals composed of genes or cells from other organisms not involved with the reproduction of those animals. These may include animals created with human genes, for instance, in order to grow transplantable organs *in vivo* and for research to find medical cures [Ekser 2012]. Manipulation of human embryos, too, can lead to human-animal chimeras, though this possibility has caused much ethical concern and debate [Greely 2003; di Melo-Martin 2008], so much so that US legislation had been proposed to prohibit this line of research, calling it an affront to human dignity as well as an existential threat [Human Chimera Prohibition Act 2005].

Not all enhancements, of course, are as fanciful as a human-chimeric warrior or a berserker mode, nor are we suggesting that any military has plans to do anything that extreme. So most, if not all, enhancements will likely not be as obviously inhuman. Nonetheless, the "conscientiousness of mankind" is sometimes deeply fragmented, especially on ethical issues. So what is unobjectionable to one person or culture may be obviously objectionable to another. Something as ordinary as, say, a bionic limb or exoskeleton could be viewed as unethical by cultures that reject technology or such manipulation of the human body. This is not to say that ethics is subjective and we can never resolve this debate, but only that the ethics of military enhancements—at least with respect to the prohibition against inhumane weapons—requires specific details about the enhancement and its use, as well as the sensibilities of the adversary and international community. That is, we cannot generalize that all military enhancements either comply or do not comply with this prohibition.

Beyond the BTWC, inhumanity as a prohibitory reason is a common theme that underlies IHL. In the preamble to the first Hague Convention:

> Until a more complete code of the laws of war is issued, the High Contracting Parties think it right to declare that in cases not included in the Regulations adopted by them, populations and belligerents remain under the protection and empire of the principles of international law, as they result from the usages established between civilized nations, from the **laws of humanity** and the **requirements of public conscience** [1899; emphasis added].

Known as "the Martens Clause", this basic principle is found throughout the laws of armed conflict, such as the Geneva Conventions and its Additional Protocols and opinions issued by the International Court of Justice [Geneva Additional Protocol I 1977; Ticehurst 1997]. As one would expect, much debate has occurred on what the "laws of humanity" and "requirements of public

conscience" are, especially related to the actual or even threatened use of nuclear weapons. And the same debate could be applied to emerging technologies, from attack drones [Human Rights Watch 2012] to human enhancements.

We will not engage that lengthy and unresolved debate here, except to note that a prohibition against inhumane weapons and methods is a fundamental principle, sometimes explicit and sometimes implied, that underwrites the laws of war and therefore relevant to an ethics assessment of military enhancements. This is also to say that an ethics assessment of new weapons, such as military enhancements—the purpose of this report—seems to be legally required by IHL, at least in the context of the Martens Clause if not also Article 36 of the Geneva Conventions, Additional Protocol I.

C. Inhumane Treatment

The concept of inhumanity is important to clarify, not just for the legal evaluation of weapons but also for the ethical limits on how combatants may be treated. The prohibition on torture [Universal Declaration of Human Rights 1948, Article 5; Reidy 2003; Garcia 2008], for instance, presumes certain facts about the human condition, such as the kinds of treatment that cause pain, how much pain a person can withstand, how much sleep a person needs, and so on. For instance, if our tolerance for pain were dramatically elevated, then what used to count as torture yesterday may no longer be so torturous today, and therefore such behavior may now be morally permissible.

More generally, ethics itself also presumes a similar set of facts about the human condition, for instance, that we are fairly susceptible to being killed. These facts inform our ethics, for instance, when self-sacrifice is permitted or prohibited and, again, what kinds of action toward others are unethical. If we change these presumed facts about human bodies and minds, then ethical prohibitions and permissions may also be affected. This gives us reasons to believe that an ethical code of behavior for robots could very well be different from how humans ought to behave; for instance, robots—to the extent that they have no instinct for self-preservation, cannot feel pain, etc.—may be permitted to sacrifice themselves in more trivial scenarios than human ethics might allow [Lin, Bekey, and Abney 2008; Ingram and Jones 2010].

At the beginning of this report's section, we suggested that there is a continuum from a fully human animal to a cybernetic organism to a fully robotic machine. This spectrum is perhaps defined by how many human body parts we replace with mechanical ones, ranging from zero to all. Enhanced warfighters, then, could fall somewhere in the middle of this continuum. If "robot ethics" is different from human ethics, at least where relevant facts about humans and robots differ, then it seems that "cyborg ethics" too would diverge from human ethics where there's a relevant difference in the construction and abilities between cyborgs and humans. Though not all enhanced persons are cyborgs, e.g., if the enhancements are genetic, pharmacological, or otherwise not robotic, we can also reasonably conclude that ethics for enhanced persons generally may be different from the standard human ethics.

So it becomes an interesting question of whether it would still be illegal or inhumane to whip a prisoner of war, or deprive him of food or sleep, if the individual can better withstand a whipping or does not have the same food or sleep requirements that normal people typically do.

These actions possibly would not cause pain or suffering, or at least as much of it, to the enhanced subject; therefore, it would be difficult to count those actions as torture.

Beyond prisoners of war, questions about inhumane treatment could be directed at how we treat our own enhanced warfighters. For instance, drill sergeants may be tempted to push an enhanced soldier harder than other ones without augmented strength and endurance, and perhaps reasonably so. But where there are prohibitions on what military trainers are permitted to do, we may need to reevaluate those rules where an enhancement might change the presuppositions about human limits that motivated those rules in the first place.

3.2 US Domestic Law[3]

The international law considered above speaks primarily to what militaries can do with their enhanced warfighters, but there is also a prior question of whether militaries are permitted to enhance their personnel in the first place. This is more a question for bioethics and related law than for the considered IHL. Here, we will briefly outline some of the key US domestic laws and regulations that would apply to military enhancements. In section 4, we will draw upon this background to more fully discuss the international standards in bioethics previously mentioned.

But here we ask, what does US domestic law say about requiring enhancements for our own military personnel? To answer that question, we can look at actual legal cases in the US that are closely related, if not directly about, human enhancements. While we had excluded vaccinations as a type of human enhancement in the definitional section of this report above—because they are designed to sustain health, not provide capabilities beyond it—we also acknowledged that this understanding was contentious: in some sense, a vaccination seems to be an enhancement of the immune system, especially considering that the patient is not sick at the time of the immunization. At the least, even if not enhancements themselves, vaccinations seem to be closely related and can inform a study on how US law might deal with military enhancements.

The US military has been vaccinating troops since 1777 [US Department of Defense 2011]. There are currently thirteen vaccinations used by the military mandated for trainees alone: mandatory vaccinations include influenza, hepatitis A and B, measles, poliovirus, rubella, and yellow fever, among others [Grabenstein et al. 2006]. The standard military policy for the mandatory administration of pharmaceutical agents is the same as the policy applied to civilians [Russo 2007]: pharmaceuticals need to be approved by the US Food and Drug Administration (FDA) for their intended use before they are mandatorily administered; and absent FDA approval, a Presidential waiver or informed voluntary consent must be obtained for the administration of an investigational drug (IND) [Russo 2007]. The US Supreme Court has held that mandatory vaccinations of FDA-approved drugs do not violate the US Constitution [Jacobson v. Commonwealth of Massachusetts 1905, 18-19]. Mandatory vaccination programs in the military have been challenged in court [United States v. Chadwell 1965], but they were rarely subjected

[3] We thank Michael Burnam-Fink, Alexander R. LaCroix, and Seth G. Schuknecht for their discussion in this section.

to substantial legal challenges until 2001, directed at the Anthrax Vaccine Immunization Program (AVIP).

A. Federal Law

As an important catalyst for US law related to vaccinations, AVIP—established in 1997—had roots in Operation Desert Shield in 1990, at which time the US military worried about biological and chemical weapons that Saddam Hussein was rumored to have possessed. At the time, the DoD argued that the informed consent requirement for the administration of INDs was impractical [Doe v. Sullivan 1991]. The requirement was feasible during peacetime, but the DoD urged that it posed significant obstacles to the safety of troops and mission accomplishment in wartime [Brown 2006]. In response to pressure from the DoD, the FDA promulgated Rule 23(d), otherwise known as the Interim Final Rule:

i. 21 CFR 50.23(d), or Interim Final Rule

Rule 23(d) allows the DoD to waive the informed consent requirement, if it is not feasible to obtain consent in a particular military operation, subject to conditions [Brown 2006]. Most importantly, the waiver must be limited to "a specific military operation involving combat or the immediate threat of combat" [Doe v. Sullivan 1991, 1374]. Upon receiving the request for waiver from the DoD, the FDA must evaluate it and grant the waiver "only when withholding treatment would be contrary to the best interests of military personnel and there is no available satisfactory alternative therapy" [Doe v. Sullivan 1991, 1374]. This rule was challenged in 1991, in *Doe v. Sullivan,* but the federal court held that 23(d) was constitutional and within the scope of the FDA's authority [Doe v. Sullivan 1991, 1381].

ii. 10 USC §1107(f)

In 1998, in response to the ruling in *Doe v. Sullivan,* the US Congress enacted 1107(f). This statutory provision requires the DoD to obtain informed consent from soldiers before administering an IND (including an approved drug for an unapproved use) and provides that the President can waive said requirement [10 USCA § 1107 (West)].

iii. Executive Order 13139

President Clinton unified both rule 23(d) and 1107(f) in 1999 with Executive Order 13139, a guideline for waiving informed consent within the context of military operations [Brown 2006, 942]. According to the order, to use an "investigational drug" or a "drug unapproved for its intended use," the Secretary of Defense must obtain informed consent from each individual service member [Executive Order No. 13139 1999]. However, a Presidential waiver can overcome this requirement, but it can only be obtained upon a written determination that obtaining consent is: (1) not feasible; (2) contrary to the best interests of the member; or (3) is not in the interests of national security [Executive Order No. 13139 1999].

iv. DoDD 6200.2

The Department of Defense Directive (DoDD) 6200.2, like Executive Order 13139, synthesized several sources of authority governing the use of INDs for military health protection [US Dept. of Defense 2000]. It defines an IND as a "drug not approved or a biological product not licensed by the FDA," or alternatively, as a "drug unapproved for its applied use" [US Dept. of Defense 2000, 2]. Further, it provides that the DoD must prefer

products approved by the FDA for use as countermeasures over INDs [US Dept. of Defense 2000, 3]. However, "when, at the time of the need for a force health care protection counter-measure against a particular threat, no safe and effective FDA-approved drug or biological product is available, DoD Components may request approval of the Secretary of Defense to use an investigational new drug" [US Dept. of Defense 2000, 3]. If the Secretary of Defense determines that obtaining informed consent is not feasible, contrary to the best interests of the member, and is not in the interests of national security, s/he can then request a waiver from the President [US Dept. of Defense 2000, 4].

B. Military Law

Military law operates in conjunction with federal civil law, but it focuses on matters germane to the military alone. In addition to the Constitution, US military law is governed by the Uniform Code of Military Justice (UCMJ). In the context of military vaccinations, the issue is about the lawfulness of the order to take the vaccination. The DoD's successful defense strategy of the legality of the AVIP throughout the anthrax cases was straightforward on this account: the vaccine was determined by the FDA to be safe and effective for use against inhalation anthrax, and under military law the legality of an order to take the vaccine was a question of law for a judge to decide, not a question of fact for determination by a jury [Katz 2001].

Under the UCMJ, disobedience of a direct and lawful order from a superior officer is punishable under articles 90 or 92. Article 90 prohibits willfully disobeying a superior commissioned officer [10 USC § 890 (1994) (UCMJ Art. 90)], and article 92 prohibits failing to obey an order or regulation [10 USC § 890 (1994) (UCMJ Art. 92)]. A soldier who refused to take the anthrax vaccination was court-martialed, where the DoD would file two interlocutory motions: (1) that the lawfulness of the order should be decided as a question of law; and (2) that all the evidence regarding the safety, efficacy, and necessity of the vaccine should be excluded because the legal authority of an order is not based on the safety of the vaccine [Ponder v. Stone 2000]. The DoD did this in every challenge to the AVIP, and in every challenge to the AVIP in military court they were successful [Katz 2001].

A strong, but rebuttable, presumption is that a military order is lawful when someone is charged with willful disobedience of a lawful order [US Government, Manual for Courts-Martial 2010; Katz 2001], and the lawfulness of a military order is an interlocutory order to be decided on by a judge, not a jury [US v. New 1999; Perry v. Wesely 2000]. What this effectively does is foreclose a legal challenge to the scientific efficacy of a vaccine on procedural grounds.

We will not delve much into the legal challenges to AVIP specifically, except to use the preceding as background as we discuss the different bioethics models in the next section. Again, while these legal issues were involved with actual cases involving vaccinations, we can plausibly extend them to anticipate how they would address technologies and procedures that are more clearly human enhancement than therapy.

3.3 Operations

Beyond the demands of international and domestic law, military enhancements likely will have important policy implications. We will examine here some of those implications on military operations themselves. (The broader

impact of enhancements on society at large has been well discussed in literature elsewhere [Allhoff et al. 2010].) Cognitive and physical human enhancements can significantly help a military achieve its missions, operate more efficiently and perhaps ethically, as well as a host of other benefits. We won't explicate these, as their applications are fairly clear. Rather, we will focus on unintended problems that may be caused by enhancements.

A. *Morale and Unit Cohesion*

Assuming that enhancements are not adopted by all warfighters at once—for instance, they are rolled out selectively or slowly for safety, economic, or other reasons—there would instantly be an inequality among the ranks. Some warfighters will be privileged (or unlucky?) to be enhanced, while others remain "normal." In broader society, we see that uneven access to technology creates a gap between the haves and the have-nots, such as the Internet divide [Rozner 1998]; and this translates into a difference in quality of life, education, earnings, and so on. It is therefore not unreasonable to expect a similar effect within the military.

At the unit level, enhancements may increase any dissension between warfighters. A mix of enhanced and unenhanced warfighters within a single unit may affect morale and unit cohesion. To be sure, similar worries had been voiced related to the integration of different ethnic groups, religions, and sexual orientation in the military [Canaday 2001]; but where these differences do not intrinsically imply different levels of capabilities or merit that would matter operationally, human enhancements do.

By definition, an enhanced warfighter would be stronger, faster, or otherwise better-abled than normal counterparts. This means they could accept riskier roles and have lower support requirements, for instance. Further, because enhanced warfighters represent a significant investment of research and effort, they may not be subjected to the hard work of fighting or other "mundane" uses. Compare this to Allied airborne troops in World War II who were pulled from the lines after the D-Day invasion of Normandy, rather than being required to slog through France and the Hürtgen Forest in Germany [O'Meara 2012b].

The asymmetry of needs and capabilities could cause resentment of the unenhanced as a drag on capabilities and operational efficiency of the enhanced, as well as resentment by the unenhanced of the superior abilities and (likely) superior status of the enhanced. To some extent, we already witness this when militaries switch their dependence from soldiers to "special operators" such as Navy SEALs [O'Meara 2012b]. The asymmetry also could create a sense of entitlement among the enhanced and undermine an *esprit de corps*, much as some superstars do on sports teams.

B. Command

Morale is relevant to confidence in command. Thus enhancements could create novel difficulties for the command structure, particularly if commanders were unenhanced and were seen as physically—or, worse, intellectually—inferior to those they command.

As one firsthand perspective, according to retired US Army Brigadier General Richard O'Meara, a social contract exists between troops and leaders that places the burden of defining the goals of a mission on the leaders and the burden of accomplishment on the troops [O'Meara 2012a,

2012b]. But while the troops have the responsibility to accomplish goals which command has set forth, they also have a right to demand that leaders make informed decisions, even if difficult ones, and to do so in a way that warfighters recognize as legitimate. It is a recipe for disaster when those further down the chain of command are continually second-guessing and evading their orders. If human enhancement exacerbates that lack of confidence in leaders, it could undermine the strategy and tactics of command.

Physical enhancements may be less problematic in this regard than cognitive ones, at least with respect to challenges to command. When the troops are generally less educated, less interested in strategy, and more concerned with communal rather than individual rights and values, command can worry less about the potential disobedience that could result from enhancements. According to O'Meara [2012b], the primary responsibility of typical enlisted soldiers is to know at all times what their superiors desire of them; their well being, even their survival, may well depend on it. Therefore, the rank-and-file are typically extremely sensitive to the wishes of command and, even when those wishes are not officially communicated, there is an expectation that a soldier will "get it" and learn to read the signs and comply, or disregard at their peril. Further, military culture is based on the assumption that the decisions of leadership are entitled to greater weight based on superior knowledge and judgment. Diffusing the power to make decisions strikes at the heart of the legitimacy of leadership; and so cognitive enhancements pose dangers to received military models that mere physical enhancements do not.

C. Service, Pay, and Promotion

Perhaps we should think about enhanced warfighters as we do with other specially trained operators, such as the Army's Special Forces or Navy SEALs. That is, military policy could be to keep the enhanced separated from the unenhanced, in special or elite units; this would reduce any friction between the two groups.[4]

However, this segregation may merely telescope the problem out to a broader level, shifting tension from within units to among different units: If special units are given access to enhancements, or otherwise treated or rewarded differently—assuming we can even think of enhancements as rewards—then other units may feel slighted. Indeed, O'Meara [2012b] identifies this kind of inequity as a primary cause for dissension in the ranks presently. So it matters to military policy who gets enhanced and when, if not also how and why.

But as we alluded to above, and discussed in the definitional section of this report, it may be an open question of whether a particular enhancement may be a benefit to the individual. Leaving disenhancements aside, some or many enhancements pose side-effect risks; for instance, we still do not adequately understand the role of sleep and long-term effects of sleep deprivation, even if we can engineer a warfighter to operate on very little or no (true) sleep, as some animals are already capable of doing. So depending on one's perspective, an enhance-

[4] There may be other reasons to segregate the enhanced, as well as countervailing reasons. We mention a few throughout this report, though if a policy to segregate were under serious consideration, it would need much further study.

ment could be a reward or benefit, or it could be an undesired risk, as some believed about anthrax vaccinations [Wasserman and Grabenstein 2003; Berkelman, Halsey, and Resnik 2012].

How, then, should enhancements affect the service commitment of military personnel? Insofar as an enhancement is costly to develop and represents an investment, it may be reasonable to expect the enhanced warfighter to commit to longer service. But if an enhancement is seen more as a risk, then perhaps a shorter length of service is appropriate for the enhanced. Similar decisions may need to be made with respect to pay, promotions, and so on. For instance, if promotions and "danger pay" may be used to incentivize volunteers, enhanced soldiers could be better positioned and more likely to accept dangerous missions in exchange for those benefits.

D. Lessons from the "Drone Wars"

On the mission side of operations, human enhancements may elicit a backlash that hinders the mission and therefore detracts from the value of enhancements for the military. This kind of blowback is already seen with the US government's use of unmanned aerial vehicles (UAVs) in the so-called "drone wars": While the US views its target strikes as appropriate—if not ethically required—to the extent that it is taking American military personnel out of harm's way in a presumably just campaign, adversaries see drones as a cowardly and dishonorable proxy for a military afraid to engage face-to-face with human resistance. This sentiment seems to fuel resentment and hatred toward the US, which in turn helps to recruit more terrorists [Foust 2012; Plaw 2012]. Similarly, if military enhancements are regarded by adversaries as cowardly or abominable, they may be counterproductive to the larger war for "hearts and minds", even if the enhancements work as designed.

Another criticism of the drone wars that may be applied to military enhancements is the charge that these technologies, by better ensuring the survival and success of our own military personnel, serve to make war more risk-free and therefore a more palatable option [Lin, Abney, and Bekey 2008; Lin 2010; Lin 2011; Human Rights Watch 2012]. That is, we may be tempted into choosing a military option during a political conflict, rather than saving war as the last resort as demanded by just-war theory. This ethical imperative is reflected in Civil War General Robert E. Lee's observation: "It is well that war is so terrible; otherwise, we would grow too fond of it" [Cooke 1876, 184; Levin 2008]. As war becomes less terrible—at least for our own side—our natural aversions to it may be lessened as well.[5]

This criticism leads to other related charges such as that drones are making it easier to wage war secretly, thus subverting democratic requirements, e.g., any due-process afforded to targets who are US citizens and the War Powers Resolution of 1973 [50 USC §1541-1548]. To the extent that enhancements can make it easier for military teams to covertly conduct missions and penetrate enemy lines, it would likewise be easier to conduct illegal operations, such as assassinations and cross-border attacks without the permission of the receiving nation-state.

[5] While reasonable on the face of it, this position could perhaps be fatally flawed, if it implies that war ought to be as terrible as possible in order to create maximum disincentive against choosing war over other options [Lin, Bekey, and Abney 2008].

Other relevant issues echo from robotics and other technologies, especially for neural devices and other cognitive enhancements. For instance, if hacking is a concern for UAVs and other robotics, then hacking is also a plausible concern for neural devices implanted or connected to the human brain [Denning 2009; Martinovic 2012]. As another example, where we struggle with questions of moral and legal responsibility with (future) autonomous robots, we may face the same questions sooner with human minds enhanced by either electronic or other biochemical means [Vincent 2012].

The above discussion certainly does not exhaust all the legal and operational issues that will arise from military human enhancements; and so more research is needed in this area. In the following section, we introduce another complication in the analysis of enhancement technologies: the impact to the warfighters themselves.

4. Bioethics

International humanitarian law is rightly the first concern in evaluating new military technologies. But with human enhancement technologies, bioethics must also come into play. Insofar as enhancements involve experimentations and interventions to the human body, bioethical demands are clearly relevant too. However, the requirement and use of enhancements by the military presents a unique challenge: Where bioethics is typically directed at preventing harm, especially to the subject, military interests often subordinates individual interests, i.e., the welfare of the warfighter, in favor of collective interests, e.g., the success of the mission. This tension makes it difficult to straightforwardly evaluate military enhancements through a bioethical lens.

In the following, we will examine three traditional models within bioethics to see how they might apply to military enhancements: the research model, medical model, and public-health model. These models are a natural frame in that the conduct of medical practitioners and researchers is plainly a central issue in military human enhancements. Further, much of bioethics carries the force of law and international norms, so bioethics is also a sensible entry point into an analysis of military human enhancements.

In the fields of military ethics and law, a significant amount of work has been devoted to creating a set of norms to govern the use of military force, including the adoption of a number of international agreements. Some of this work focuses on medically-related issues, such as the medical treatment of prisoners and one's own troops injured in battle, the use of unapproved or experimental drugs to prevent injury, and torture.

A few commentators also have discussed military enhancement. In 2007, an entire issue of the journal *Aviation, Space, and Environmental Medicine* was devoted to the "Operational Applications of Cognitive Performance Enhancement Technologies" [Aviation, Space, and Environmental Medicine 2007]. In 2008, the *American Journal of Bioethics* published a paper and accompanying commentary on the use of military enhancements that compromise moral judgment [Wolfendale 2008; Ashcroft 2008]. Most recently, Catherine and George Annas wrote a piece in the *Journal of Contemporary Health Law & Policy* that focused on the role of physicians in giving soldiers prescription drugs for enhancement purposes [Annas and Annas 2009]. However, none of these efforts has articulated the basic ethical and legal norms that ought to govern the military use of biomedical enhancement; and research continues in this area [Gross and Carrick forthcoming; Giordano forthcoming].

At first, identifying a specific set of norms for military enhancement might seem superfluous. Wouldn't these be the same basic norms that govern military medicine in general? But there is no consensus yet about what *those* norms are. More importantly, as will be seen, the use of biomedical enhancement by the military does

not comfortably fit current models of military medical care.

Alternatively, the norms pertaining to performance enhancement in sports might be thought to be an appropriate ethical and legal framework for military enhancement. But there is still controversy over what the norms in sports ought to be [Mehlman 2009b]. Moreover, even if one takes the position that doping in sport is unethical, a persuasive argument can be made that sport is not a good analogy for the military, e.g., enhancements in sports may confer benefits on individual athletes and teams, but they do little for society.

Perhaps the only way sports doping might be said to produce public good is by promoting national prestige in international competitions such as the Olympics, which could aid in winning confrontations such as the Cold War, and perhaps by making some sporting events more exciting for fans, which could boost revenues for sponsors and investors. In the military, on the other hand, safe and effective biomedical enhancements could produce significant societal benefit by promoting the welfare of warfighters to better accomplish missions in the national interest—potentially decreasing collective risk. As Hilary F. Jaeger states:

> In the case of sports, the benefit sought is victory, symbolized by the awarding of a medal or trophy, admittedly frequently accompanied by attendant rewards such as fame and financial gain. The risk in sports is almost purely the risk to the athlete's health of using the performance enhancing substance, along with any risk of embarrassment, legal action, loss of income, or sanction that may accompany being caught using controlled or banned substances. In sports, using performance enhancement is inherently wrong not only because it is cheating, but also because it poses a totally unnecessary threat to an individual's health. This latter reason is of more direct concern to the physician. In military operations the reward, on the collective level, is also victory—but a victory of far greater importance than any sporting trophy. On an individual level the reward is survival, ideally survival without injury. The risks are more complex to characterize, for while there are the identical types of risks associated with the use of the performance enhancing substance, there is also the countervailing risk to life and health of undertaking military operations in a less than ideal cognitive or physiologic state. One does not normally think of performance enhancement as "cheating" in a military operational context; rather, the search for asymmetric advantages, within the bounds of the Law of War, is both good strategy and sound tactics [Jaeger 2007].

In short, we need to identify the appropriate ethical and legal framework. In doing so, we will see how much of what we need can be imported from the normative regimes of research, medical practice, and public health.

4.1 Research Model

Members of the military might be given biomedical enhancements as part of a formal research study. A formal research study, to quote from the Belmont Report, is "an activity designed to test a hypothesis, permit conclusions to be drawn, and thereby to develop or contribute to generalizable knowledge…" [National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research 1979]. Two

prerequisites must be fulfilled in order for something to count as a formal research study: (1) the endeavor must be conducted according to basic principles of scientific research, and (2) the primary intent of those conducting the endeavor must be to produce knowledge, rather than to provide benefit to specific individuals, in particular, to the subjects.

The military can be expected to conduct formal research studies on biomedical enhancements using military personnel as subjects. It already has conducted several experiments on modafinil [Caldwell and Caldwell 2005], including one at Walter Reed Army Medical Center in 2002 comparing the effects of modafinil and caffeine [Wesensten et al. 2002]. (As noted earlier, DARPA and other military agencies also may sponsor research using civilians as subjects, a topic that is beyond the scope of this report.)

However, the military has a checkered past when it comes to human experiments, even on its members. Beginning in 1952, the Army tested incapacitating agents, including nerve agents, nerve agent antidotes, psychochemicals, and irritants, on 7,120 service personnel without obtaining their informed consent. The program was halted only in 1975 [United States General Accounting Office 1994]. In the 1950s and 1960s, the Defense Department, in cooperation with the CIA, gave LSD and the hallucinogen quinuclidinyl benzilate to servicemen without their consent; many of the experiments were conducted under a program known as MKULTRA, which was established to offset reported Soviet and Chinese progress in perfecting brainwashing techniques [US Congress 1994]. Given these questionable practices in the past, protecting the welfare of military research subjects in the future is especially important [Parasidis 2012].

Formal research studies conducted on military personnel are subject to a reasonably well-defined set of ethical and legal rules derived from the so-called Common Rule (32 CFR §219.101 ff). This rule was a refinement of rules that were first enunciated in 1946 in the Nuremberg Code, followed in 1964 by the World Medical Association's Declaration of Helsinki, and most notably, the 1979 Belmont Report by the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research, which eventually led to federal regulations known as the Common Rule.

The Belmont Report enunciates three overarching principles: "respect for persons," "beneficence," and "justice." The first requires that competent individuals be asked to give their informed consent to participate as research subjects and that protections be afforded to persons who are not competent to give their consent. Beneficence—related to the principle of "nonmaleficence" or to do no harm—requires that the risks to subjects be minimized and the potential benefits maximized. It should be noted, however, that the benefits of research need not redound to the subjects themselves; the study may involve gathering basic knowledge rather than providing health benefits, and the knowledge may benefit others or the population in general rather than the subjects themselves. In the context of medical research, justice requires that subjects be chosen fairly and that the benefits from the research, if any, be widely available. The primary responsibility for seeing that research fulfills these requirements rests with the researchers, but the Common Rule establishes a system of institutional review boards (IRBs) to ensure that these requirements are carried out.

The Common Rule also creates special protections for certain populations deemed "vulnerable" because of mental limitations impairing an individual's ability to weigh risks and benefits, and because of external conditions and pressures that impair an individual's ability to make voluntary decisions about whether or not to serve as subjects. The rule recognizes a number of specific vulnerable populations including children, pregnant women, and prisoners, but members of the military are not explicitly among them. The individual services have the discretion to establish their own special protections. The US Army, for example, requires most human subjects research to go through two layers of IRB review: (1) the IRB at the institution that actually conducts the experiments, and (2) the Human Subjects Research Review Board, a unit under the command of the Army Surgeon General.

The manner in which IRBs should review protocols for military research, however, is unclear. The fact that military research is intended to further national security interests may lead IRBs, especially those within the military, to approve studies that pose risks that would be unacceptable in civilian-sponsored research. This may very well be ethically and legally appropriate in view of the potential benefits to the nation, but both IRBs and researchers lack clear guidance on how these risks and benefits should be balanced. On the other hand, due to concerns about the inability of service members to provide truly voluntary informed consent, IRBs may reject studies using military subjects that would be approved if the subjects were civilians.

For example, how should IRBs consider the fact that, by enlisting, service members have volunteered to accept greater risks than members of the civilian population? In addition, military IRBs may be susceptible to undue influence due to the "command culture" in which they function. For instance, commanders choose the members of military IRBs, although subject to requirements concerning board composition [Amoroso and Wenger 2003]. Furthermore, some military research may be classified, which creates special challenges for researchers and IRB review. Finally, federal regulations forbid IRBs from considering "possible long-range effects of applying knowledge gained in the research (for example, the possible effects of the research on public policy) as among those research risks that fall within the purview of its responsibility" [45 CFR §46.111(a)(2)]. It is not clear how this restriction should affect IRB consideration of the long-range effects of military research. The result may be that IRBs approve military enhancement research that they otherwise should not, as well as block or unreasonably delay studies that otherwise should go forward.

According to US Department of Defense rules, research using military subjects, like civilian research, ordinarily cannot take place without the informed consent of the subjects, and the military recognizes the importance of insulating soldiers being solicited to participate in experiments from undue pressure from their superiors. For example, both service and Department of Defense regulations provide that "[u]nit officers and non-commissioned officers (NCOs) are specifically restricted from influencing the decisions of their subordinates to participate or not to participate as research subjects," and add that "[u]nit officers and senior NCOs in the chain of command are required to be absent during research subject solicitation and consenting activities" [US Army, Human Research Protection Office 2005]. Service regulations also require that informed consent forms include a statement that "participation is voluntary, that refusal to participate will involve no penalty or loss of

benefits to which the subject is otherwise entitled, and that the subject may discontinue participation at any time …" [US Army, Office of the Surgeon General 1989].

There are two exceptions to the requirement that military subjects must give their informed consent to participate in research. One is for "emergency research," that is, studies of techniques to treat soldiers with medical emergencies who, because they are unconscious or otherwise *non compos mentis*, cannot make their own decisions [10 USC. §980, 21 CFR §50.24]. (A similar exception recently has been recognized for non-military research) [US Department of Health and Human Service, Office of Human Research Protections 1996].

The second exception was adopted during the first Gulf War. In that conflict, the military wanted to give troops pyridostigmine bromide (PB) and botulinum toxoid (BT) vaccine to protect them against nerve agents and botulism. The FDA had approved PB for myasthenia gravis, but not for protection against nerve agents [Fitzpatrick and Zwansiger 2003], while BT vaccine was produced by the Centers for Disease Control and Prevention under an experimental Investigational New Drug exemption [Wykoff 1998]. (Similar issues have been raised by the DoD's Anthrax Vaccine Immunization Program, initiated in 1997 using a newer version of a vaccine that had been approved by the FDA for subcutaneous anthrax but that had not been approved to protect against the aerosolized exposure anticipated by the military [Nass 2002].) In the Gulf War, the DoD claimed that PB and BT vaccine were the best protections against feared Iraqi use of biological weapons and that it was not "feasible" to obtain consent from US troops [Gross 2006]. The DoD therefore asked the FDA for a waiver of the informed consent requirement. The FDA agreed and issued an interim rule that permitted the commissioner of the FDA to allow the DoD to use a drug or biologic that was not approved or not approved for the use in question so long as (1) the DoD was requesting the drug to facilitate a military mission and preserve the health of servicepersons in a military situation that involved "combat or the immediate threat of combat," (2) permitting some servicepersons to refuse to take the drug would threaten national security and the best interests of military personnel, (3) informed consent was not feasible, (4) there was no other available intervention, and (5) an institutional review board had approved the DoD request [Gross 2006]. In 1999, the FDA issued a final rule that transferred the authority to issue the waiver from the commissioner of the FDA to the President [Food and Drug Administration, Protection of Human Subjects 1999].

There is considerable debate on whether the use of PB and BT vaccine in the Gulf War were in fact formal experiments. The disagreements are due partly to confusion over the regulatory status of these products and the ethical and legal implications of that status. Fitzpatrick and Zwanziger, for example, call the use of these drugs "investigational," [Fitzpatrick and Zwanziger 2003] but technically that means that the military was studying the drugs in formal clinical experiments, which was not the case. Wolfendale and Clarke call them "experimental drugs that had only been subjected to partial testing" [Wolfendale and Clarke 2008, 343]. Again, neither drug was experimental in the sense that they were being studied in formal military experiments, and PB had been fully tested for its approved indication, myasthenia gravis.

The correct description of PB is that it was an FDA-approved drug that the military was using for an unapproved use. Unapproved or "off-

label" use of drugs is commonplace in medicine: one study found that more than 20 percent of all prescriptions written by doctors in their offices were for unapproved uses, with the percentage of off-label prescribing for cardiovascular ailments as high as 46 percent [Radley, Finkelstein, and Stafford 2006]. The study also found that 50 to 80 percent of cancer patients receive chemotherapy on an off-label basis. Moreover, it is not clear that doctors are required to notify patients that they are being prescribed drugs for off-label uses [Richardson 2012]; and if physicians in general are not required to do this, it is not evident why a different rule should be adopted for military physicians. In the case of BT vaccine, the FDA had not approved it for any use, but the vaccine enjoyed an odd regulatory status; it was the only vaccine available against botulism, had been used to protect people against it for years, and was manufactured for that purpose by the US government itself. Therefore, it too was not in quite the same regulatory category as a typical experimental product, that is, a new drug produced by a commercial drug company with limited information available concerning its safety or efficacy.

Even if PB and BT vaccine had been entirely new and untried, it is still not clear that giving it to soldiers going into combat against a foe believed to be willing to employ biological weaponry should have been treated as human experimentation, or that the full protections in the Common Rule—in particular, the requirement of obtaining the subjects' informed consent to participate—should have been triggered. Fitzpatrick, Zwanziger, Wolfendale, and Clarke maintain that this use would not be formal research because, although the military clearly was interested in seeing what effect the substances had on those who took them, the primary intent of the commanders who gave the substances to the troops was not to produce knowledge but rather to protect them against an Iraqi attack. Catherine and George Annas disagree, claiming that the commanders' intent is irrelevant. What counts, they say, is the regulatory status of the product: if it is experimental, then any use of it is an experiment, and the Common Rule applies. The Annases are onto something; their opponents do seem to be suggesting that the military can circumvent the human subjects protections in the Common Rule simply by declaring that the intent is to provide benefit to the troops rather than to gain knowledge.

But the Annases overlook the fact that, as discussed more fully below, warfighters are not accorded the same degree of voluntary choice as civilians. As Michael Gross explains, "an ordinary patient who refuses a vaccine in the face of a deadly threat suffers, at worst, his own death. Ordinarily, this is an acceptable outcome provided the patient is competent and well-informed. In other settings, however, it is unacceptable, not because a person dies but because he decimates a fighting force." Gross overlooks the fact that people who refuse to be immunized risk the well-being of family and community as well as themselves, but he is correct in that the welfare of the individual warfighter is neither the only nor indeed the paramount consideration in the military. "In many cases," Gross adds, "investigational drugs are, in fact, sufficiently risky to convince any self-interested person to refuse treatment. Yet this decision, however rational and well informed it may be, may easily harm collective endeavors. This is the essence of any collective-action problem that plagues institutions like the military and a difficulty that only coercion can generally overcome" [Gross 2006].

In any event, the experience with PB and the BT vaccine suggests that it may be difficult for warfighters to determine whether or not they were being given biomedical enhancements as part of a formal biomedical research study. In those instances, commanders simply ordered troops to take a pill or receive an injection, in the same way they ordered them to go certain places, take rests, or engage the enemy. Even if the commanders had informed the troops that the pills and injections were experimental, as a practical matter, the troops may have felt constrained to obey the commanders' orders.

Michael Russo illustrates this point by quoting from a 1991 autobiographical novel about the Gulf War written by a US Marine, Anthony Swofford: "'We listen to an officer from division NBC [Nuclear, Biological, Chemical] tell us again that the PB, pyridostigmine bromide, pills aren't harmful, that they will help us …' The staff sergeant informs the platoon that, 'We will have three formations per day and at each of these formations you will take one of these goddamn pills. Don't f'ing ask me what it is. I'm taking it too. Do you want to f'ing live, or do you want to f'ing die?' Swofford adds, 'Later I will read that PB has been approved under the condition of full disclosure … and the individual service member will choose whether he or she want to take the pills. This is, of course, not the way it works in the military.'" Russo adds that "although standard US military informed consent policy has recently been clarified, the reality in a field environment is that well-intentioned policies often may not be enforced effectively" [Russo 2007]. A solution might be to restrict military enhancement research to subjects who were noncombatants, but this may not adequately reproduce the conditions on the battlefield under which the experimental intervention was expected to be employed; and a lengthy research trial may fail to comply with the urgency of "military necessity."

Finally, even if they were permitted to decline to give their consent to participate in an enhancement research study, the instinct for self-preservation is likely to lead warfighters to grasp at any means of improving their chances of surviving battle, including exposing themselves to the risks of experimentation in order to gain access to experimental enhancements. This is all the more likely if the experimental intervention is new and scientific.

As Hilary Jaeger writes about alertness drugs, "when selecting between possible interventions, I believe they will favor those that appear high-tech, novel, sophisticated, and in keeping with a warrior ethos (like cogniceuticals) over interventions that are low-tech and decidedly pedestrian (like managing work and sleep appropriately)" [Jaeger 2007]. This is especially likely to be true of special forces troops, even though, as Wolfendale and Clarke write, "special forces operations are usually high risk, small scale, and unpredictable," and for these reasons, "special forces personnel generally have more opportunities to exercise autonomy than ordinary military personnel" [Wolfendale and Clarke 2008, 354].

If it is proposed to give warfighters biomedical enhancements as part of a formal research study, the question arises whether the fact that the study is on an enhancement rather than on a health-oriented intervention should affect the analysis of the ethical and legal appropriateness of the study. This question was the subject of a series of papers flowing from a US National Institute of Health (NIH) grant that one of the authors received to study human subjects protections for genetic enhancement research, [Mehlman et al. 2009; Mehlman et al. 2010] and

the reader is referred to those papers for a fuller discussion of the issues. Aside from recognizing that, for the reasons mentioned above, warfighters would be a vulnerable research population that requires special protection from pressure by superiors, the papers argued that there is nothing inherent in enhancement research that requires a significantly different approach toward the balancing of risks and potential benefits than in non-enhancement research.

So far we have discussed the issues raised by formal enhancement research largely from the perspectives of the subjects and their commanders. But there is an additional perspective that must be considered: that of military researchers who are physicians. As physicians, they are subject not only to the general ethical and legal rules that protect human subjects, but to special rules that govern physicians who are acting as researchers. The question, however, is whether these rules change when the physician researcher is a member of the military.[6] This leads to the broader question of what rules should govern military physicians who participate in giving warfighters enhancements in non-research—that is, deployment—settings. Even if warfighters are not given enhancements directly by a physician, the fact that these interventions are biomedical in nature may suggest that, from an ethical and legal standpoint, giving them to warfighters should be treated essentially as the practice of medicine. The question then becomes what ethical and legal rules for military enhancement are suggested by a medical as opposed to a purely research model.

4.2 Medical Model

The medical model shares many elements with the research model. It too usually emphasizes patient autonomy, including voluntary, consensual, informed decision-making, and protections for persons who are not competent; justice; and beneficence, which entails maximizing benefits to patients and minimizing risks. But many theorists—for example, the followers of Nel Noddings [1984]—claim that, beyond abstract, universal principles, the proper medical model must also take into account narrative, case-specific interpretation. Following the work of Carol Gilligan [1982] and others, care theorists press the case that interpersonal values such as love, care, and responsibility also are required for a proper medical model. They usually emphasize that such values are needed for capturing contextual subtleties of physician-patient interactions, and they advocate recognition of relational bonds that are overlooked within principle-oriented frameworks.

But on any account, the research and medical models differ in at least one key respect. In the medical model, the physician essentially owes her loyalty, care, and other values exclusively to the patient, a principle that the law reflects by treating the physician as a fiduciary for the patient. This means that everything the physician does in connection with the patient must be in the patient's best interest, and that the physician may not sacrifice the patient's welfare for that of the physician or anyone else. Principle VII

[6] A further complication: one condition of employment in the military for medical doctors is membership in a state medical association. What happens when the state association decides that the particular activity of a military physician is unethical? This issue has been raised in connection with psychologists who were alleged to have been experimenting with torture techniques at Guantanamo Bay detention camp [O' Reilly 2011].

of the Code of Ethics of the American Medical Association puts it succinctly: "A physician shall, while caring for a patient, regard responsibility to the patient as paramount."[7]

Applied to military physicians giving biomedical enhancements to a warfighter, the medical model would hold that the physician must ensure that the enhancement is in the warfighter's best interests, that the warfighter's well-being is not being sacrificed for the welfare of anyone else, especially not that of the physician, and that the warfighter gives informed consent to using the enhancement.

Some sources claim that the role of a physician in the military is no different from the physician's role in any other setting, and that the same ethical norms and legal rules apply. The World Medical Association (WMA), for example, states that "medical ethics in times of armed conflict is identical to medical ethics in times of peace" [Gross 2006]. Peter Clarke declares that "the failure of medical professionals to recognize that military and civic duty can never trump medical ethical principles is clearly an injustice" [Clarke 2006].

But what the WMA and others who hold to this view primarily are focusing on is whether military physicians can be a party to the mistreatment of prisoners and can participate in developing ways of causing physical and mental harm to adversaries. Thus, Clarke's article discusses abuses at Guantanamo and Abu Ghraib, while the WMA's "Regulations in Times of Armed Conflict" state that "it is deemed unethical for physicians to … [e]mploy scientific knowledge to imperil or destroy life," and that "privileges and facilities afforded to physicians and other health care professionals in times of armed conflict must never be used for other than health care purposes" [World Medical Association 2012 revision]. The view that physicians may not help make tools of war is not universal, incidentally. According to Michael Gross, for example, "the medical community … cannot pursue business as usual during armed conflict and ignore the need to help build weapons that require medical expertise" [Gross 2006, 331]. Moreover, the

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[7] There are only two well-recognized exceptions to the requirement of physician fidelity to the patient. One is when the physician reasonably believes that the patient is about to cause serious harm to an identifiable third party. In that case, the physician is permitted and even obligated to breach the confidentiality inherent in the patient-physician relationship and make a reasonable effort to prevent the harm from taking place, such as by warning the person at risk, even if doing so would be at the expense of the patient's privacy, autonomy, or freedom. See Tarasoff v. Regents of the Univ. of California, 551P.2d 334 (Cal. 1976). The second exception, emergency triage, is where there are more patients than the physician can handle; the physician is permitted to use a utilitarian calculus to decide which patients to treat first in order to do the most good for the most patients, even if that means sacrificing the well-being of one or more patients for the benefit of others.

Some commentators, notably Haavi Morreim [2003], argue that a physician does not owe exclusive loyalty to the patient when the physician is acting as a researcher and enrolls her patient as a research subject. In this circumstance, they argue, the physician cannot be expected to act exclusively in the patient's interest, since as a researcher, the physician also owes a duty of loyalty to the rest of the subjects and to the study sponsor. Morreim's suggestion that a physician can breach her duty of loyalty to the patient when the physician faces a conflict of interest is by no means universally shared, with others asserting that it is precisely when the physician faces a conflict of interest that the duty of paramount fidelity to the patient is most needed.

WMA's reference to "armed conflict" may indicate that they would take a different stance in times of relative peace.

But even if the WMA's position on these issues were correct, its views on weapons production and the treatment of adversaries would not necessarily tell us how military physicians should behave *toward members of their own armed forces*. It is clear, for example, that at least in some respects, patients who are members of the military clearly do not have the same rights as civilian patients. For instance, competent civilian patients have a right to refuse treatment, but it is generally understood that warfighters do not have the right to refuse care that physicians deem necessary to return them to active duty [Gross 2004; Wolfendale and Clarke 2008, citing Annas 1998]. As Michael Gross observes, warfighters also have far fewer rights in regard to privacy and confidentiality:

> During war and among one's own soldiers, the scope of the private sphere decreases and that of the public expands as collective welfare takes precedence over an individual's private good. Thus, a wide range of private information is relevant during war that is not particularly interesting in other settings. This includes a person's emotional stability, propensity for aggression or unsocial behavior, or difficulty with authority—anything, in fact, that could upset the discipline and cohesiveness necessary to maintain effective fighting capabilities [Gross 2004, 121].

In short, according to Gross, in the military "the hallmark principles that drive bioethical decision-making in ordinary clinical settings are largely absent. Military personnel do not enjoy a right to life, personal autonomy, or a right of self-determination to any degree approaching that of ordinary patients" [Gross 2004, 15]. As he puts it starkly, "combatants lose their right to life as they gain the right to kill" [Gross 2004, 23].

More importantly, it seems fairly settled that in the military, it is at least sometimes acceptable to subordinate the welfare of individual warfighters for the greater good, namely, the welfare of the unit, the mission, and the state. "During war," Gross explains, "human life is of but instrumental value. … Kant's maxim to treat others as ends guides bioethics. But it does not guide war. During armed conflict, there is very little compunction about using persons as means" [Gross 2004, 171-172]. "Unlike bioethical principles," he adds, " … the principles of contemporary just war often reach beyond the welfare of a single individual—that is, the patient—to consider instead the aggregate interests of combatants and noncombatants, and the collective interests of the state. At the same time, they must also contend with military necessity" [Gross 2004, 15]. As a result, Gross says, "military necessity reflects a concern for the collective welfare of the political community that reaches beyond individual well-being and sometimes overrides the normative force of deontological moral principles central to bioethics" [Gross 2004, 59]. The reason, explains Bill Rhodes, is simple:

> The interdependence that business life embodies may determine whether the business flourishes or withers, but even in the worst case of bankruptcy or dissolution, the unemployed will still be alive. A failure in business operations may destroy a business, but it will likely not cost anyone's freedom or life. In cases where lives are at stake, as in a surgical theater or an airplane, the requirements for good organization and teamwork become

> more stringent, but even then failure will not risk a state's sovereignty. But a failure to work well as a military setting may end up destroying the military itself and put at peril the nation it was supposed to defend. For this reason, militaries put tremendous emphasis on an ethical requirement to value the needs of one's group above personal desires. Sometimes this is referred to, as in military "core values" statements, as the virtue of selflessness. In its highest manifestation, an individual's identification with his unit is so thoroughgoing that he sees little distinction between the unit's well-being and his own. … Fear of failing one's subordinates or failing to accomplish the mission that others are depending on become predominant ethical worries [Rhodes 2009, 54].

One consequence of the subordination of the individual, as Gross points out, is that "soldiers are not fully autonomous individuals … Without autonomy in its most expansive form, its derivative patient rights—informed consent, confidentiality, and the right to die—weaken" [Gross 2004, 101]. Bill Rhodes agrees. "[T]he needs of the state," he says, "openly supersede the preferences of the member, and in many cases the member is legally committed to serve regardless of her inclinations. The military member frequently is unable to control her own occupational destiny, especially in those states that subordinate the military to civilian control. Moreover, the soldier is legally bound to do the state's bidding even at substantial personal inconvenience or hardship. Indeed, a military member is expected to serve the state unto maiming, capture, or death" [Rhodes 2009, 50-51]. The warfighter's reduced autonomy thus leaves little role for consent, since as Rhodes observes, "the moral obligation to obey orders pervades military life" [Rhodes 2009, 57].

However, while it seems accepted that the interests of the unit, mission, and state can trump the interests of individual warfighters and leave them little in the way of personal autonomy, it is not obvious how this should affect the role of military physicians or the use of biomedical enhancements. At what point do individual interests stop mattering? How much harm may a physician cause a warfighter for the greater good? Could a physician, for instance, remove a soldier's kidney in order to transplant it into a superior? A soldier's heart? In terms of biomedical enhancements, how much risk is too much? And who gets to decide what constitutes "acceptable risk": the commanding officer, the military physician, the warfighter himself, or someone else? (We return to this topic in the next section on risk).

Gross admits that the warfighter may retain some individual choice. But how much is not clear:

> Informed consent is the hallmark of bioethics, yet allowing soldiers to decide medical care for themselves might be chaotic. Where does one draw the line? May one compel a soldier to accept standard medical care but allow them to choose experimental care that might protect them against novel biological and chemical agents? The answer is not clear. If soldiers have but limited autonomy, on what basis may they refuse experimental or investigational drugs? This issue turns partly on acceptable risk during war and on the difference between military risk and medical risk. If a commander may expose his soldiers to significant military risk to gain an important military objective, may he not accept a similar level of medical risk when treating them [Gross 2004, 17]?

Even without resolving these questions, the medical model, with its emphasis on patient welfare and autonomy, does not seem capable of serving as the sole guide for determining the circumstances in which it would be appropriate for physicians to give enhancements to warfighters. This conclusion is reinforced in cases where enhancements are given to warfighters by persons who are not physicians, such as their unit commanders. Nor does the fact that warfighters were being given something biomedical alter this conclusion. Many biomedical products are transferred from one person to another without being deemed the practice of medicine, such as the sale of illicit drugs on the street.

But there is another ethical and legal model with a medical dimension that is worth considering. Like the medical model, it deals with issues of health and welfare, but unlike the medical model, it does not give priority to individual well-being or autonomy. This is the model that governs matters of public health.

4.3 Public-Health Model

The US Constitution gives the government the "police power" to protect the public from being harmed by its members, and while the police power may be most closely associated with law enforcement, one of its most important applications is to protect the public's health. The scope of this government power is very broad. As Larry Gostin writes, "public health has constrained the rights of individuals … to protect community interests in health" [Gostin 2000, 20]. Public health authorities sequester not only people who are known or suspected of having a transmissible disease, but those who merely have been exposed to such a disease, for example, by having traveled in a country where it is found.

Furthermore, people incarcerated in this way, called quarantine, can be held for long as long as public health officials deem necessary to insure that they have gotten over the disease or are no longer contagious, to demonstrate that they were not infected in the first place, or, as in the case of Mary Mallon, aka "Typhoid Mary," who spent a total of 26 years confined to an island in the East River, as long as necessary for them to die. In the 1990s, for example, New York City confined over 200 people for approximately six months after they refused to be treated for drug-resistant tuberculosis [Tyson 2004]. In addition to quarantine, public health officers can invade people's privacy by requiring them to reveal the identity of those with whom they have come into contact, a practice known as contact tracing. Contact tracing has been used in an attempt to combat the spread of HIV, particularly in San Francisco; the contacts in that case were sexual partners, which illustrate the degree to which individual privacy may be compromised in the interest of protecting the public's health.

In addition to quarantine and contact tracing, public health officers can forcibly treat people, compel them to be vaccinated, and obtain a sample of blood from a newborn before it leaves the hospital with its parents. Added to this is the power of the states to pass laws defining and punishing unhealthy behaviors, which can run the gamut from operating an unsanitary restaurant kitchen to transmitting a venereal disease.

Public health ethics and law thus differ from medical ethics and law. This was starkly illustrated during the early stages of the AIDS epidemic, when physicians balked at efforts by public health authorities to force them to identify

patients who were HIV positive, arguing that it would violate their duties to maintain their patients' confidentiality and protect them from the stigma and discrimination provoked by the disease.

In fact, the public health model differs from the medical model in precisely those respects that differentiate the medical from the military model and that make the medical model ill-suited to govern the use of enhancements by the military. Like the military model, public health is based on utilitarian rather than deontological principles, subordinating the well-being of the individual for the good of others, and like military commanders, public health officials can use coercion if an individual refuses to consent to do what they deem necessary to protect the public health.

The public health model therefore seems ideally suited to serve as a source of ethical and legal guidance for enhancement use by the military. Fitzpatrick and Zwanziger refer to this model, for example, in discussing the ethics of giving drugs like PT and BT vaccine to troops in the field [Fitzpatrick and Zwanziger 2003].

The analogy between the requirements of public health and military necessity is well precedented. Indeed, in the single US Supreme Court decision upon which the public health authority of the state is based, a 1905 opinion in a case involving a Cambridge, Massachusetts, man's refusal to be vaccinated against smallpox, Justice Harlan analogizes the state's exercise of its public health powers to its power to compel a citizen to risk his well-being in time of war: "He may be compelled, by force if need be, against his will and without regard to his personal wishes or his pecuniary interests, or even his religious or political convictions, to take his place in the ranks of the army of his country and risk the chance of being shot down in its defense" [Jacobson v. Commonwealth of Massachusetts 1905].

Yet as Justice Harlan also recognized, the authority of public health officials to override individual interests and autonomy is not absolute. "According to settled principles, the police power of a State must be held to embrace, at least, such *reasonable* regulations established directly by legislative enactment as will protect the public health and the public safety" [Jacobson v. Commonwealth of Massachusetts 1905, 25; emphasis added]. Harlan goes on to make it clear that the courts will not uphold public health actions that are "arbitrary or unreasonable" or "cruel and inhuman," and that the state cannot force someone to do something that would "seriously impair his health, or probably cause his death" [Jacobson v. Commonwealth of Massachusetts 1905, 48]. Public health officials have been condemned, for example, for conducting the experiment at Tuskegee where African-American men were left untreated for syphilis in order to chart the course of the disease, not to mention for leading the eugenics movement in the early 20th century that involuntary sterilized tens of thousands of Americans and that inspired the Nazi eugenics program. So the question is what limits are there on the exercise of the state's public health powers, and how would those limits apply to the military's use of enhancements.

A good starting point is a 2002 article by James Childress and colleagues [Childress et al. 2002]. They assert five principles to guide when individual welfare and autonomy may be overridden to achieve collective public health benefit: First, the public health action must be effective to protect the public health. In the authors' words, "infringing one or more general moral considerations will *probably* protect public health" [Chil-

dress et al. 2002, 173; emphasis added]. Second, the public health benefits must outweigh the burdens on those who bear them. Third, the public health action must be necessary, in that there are no effective alternatives. Fourth, the burdens must be minimized as much as possible. Finally, the action should be transparent, that is, accompanied by notice and public justification.

How would these principles apply in the military, and specifically, to military use of biomedical enhancements? The first principle suggests that the military must reasonably believe that, more probably than not, use of the enhancement would achieve a legitimate military objective. This raises a question about how much evidence of effectiveness the military needs. Giving warfighters an enhancement that was experimental, for example, might not be permissible according to this interpretation, at least if the enhancement had undergone little or no human testing, e.g., not beyond a Phase I clinical trial. However, the use of the experimental enhancement might still be permissible if the use was regarded as human experimentation and the experiment was conducted according to the rules for military experiments.

On the other hand, it is not clear that Childress et al. (hereinafter "Childress") are correct when they require that a public health intervention "probably" will protect the public health, since if a public health emergency were dire enough, the authorities surely would be permitted to force people to take a completely untried preventive measure if, as mandated by Childress' third principle of necessity, no better alternative was available.

In short, Childress' model needs to more carefully consider how the first and third principles interact; applied to military enhancements, the more necessary the use of the enhancement to protect the unit, enable the mission to be completed successfully, or promote the national interest, the less certain it must be *ex ante* that the enhancement will be effective. Childress' third principle seems to reflect this interplay by balancing benefits and burdens; the greater the benefit from the military enhancement, the greater the burdens that can be imposed on the warfighter who is given it. What is key here, however, is to understand that, as in the public health model, the benefits in question may not redound to the warfighter who bears the burdens.

The fourth principle also reflects this balancing notion if the requirement to minimize risks as much as possible is qualified with "under the exigencies of the military need." Similarly, the fifth principle can be interpreted as calling for as much transparency as is compatible with military necessity.

The public-health model, then, moves us closer to an appropriate framework with which to evaluate military enhancements. But at the same time, it loses features in the research and medical models that also seem relevant. In the next section, we will consider a risk-based model before we offer a hybrid framework that integrates the salient features distributed across these distinct models.

5. Risk Assessment

Much of the debate on human enhancement technologies starts from the standpoint of traditional bioethics. The usual ethical principles applied are familiar to medicine, such as nonmaleficence, the physician's injunction to do no harm. But emerging technologies blur the line between what is medicine and what is engineering. In such circumstances, such as in the human enhancement debate, it is appropriate to use conceptual tools from engineering ethics as well, such as risk-benefit analysis (RBA).

Which such risk assessment may be a less obvious frame than bioethics, this extra perspective helps to fill gaps in bioethical analysis, which is made more complicated by enhancements used in a military context, especially those affecting the mind. Military research is a major driver of scientific and technological innovations, from basic science and energy research to robotics and human enhancements; so we cannot ignore military applications, especially since they involve ethically difficult issues related to life and death [Lin 2010]. Enhancements, further, deal with perhaps the least understood and most complex biological system—the human brain—with implications for moral and personal identity, and so pose both medical and metaphysical risks.

A further virtue of this model is that it more directly addresses the concept of "risk", which is invoked in bioethics—and the preceding discussion in particular—but not explicated as it is in risk assessment. The risks we address in this section are primarily related to harmful but unintended consequences, including behavior of the subject, that may arise from human enhancement in the military. We also explore later a range of other risks and issues involving *intentional harm* in the course of the conduct of war. Where the preceding discussion deals predominantly with harms to the human subject, we will here also consider harms to others.

In this section, we will discuss the concept and nature of risk and its proper assessment, including the proper definition and understanding of the concept of risk itself—e.g., as "expected risk" in a risk-benefit analysis—as well as its various components of "(un)acceptable risk", including involuntary, nonvoluntary, simple voluntary, and informed consent to risk, as well as questions about the affected populations at risk, the seriousness or damage potentially caused by the risk, and the probability of the harm or lack of benefit of the risk occurring. Further, whether the risk is acceptable or not, we will examine what can be done to remedy or compensate for the possible harm caused by the risk. In so doing, we will examine the nature of RBA as intrinsic to risk assessment, and examine possible alternatives to standard RBA, such as the Precautionary Principle(s). We will also examine popular misapprehensions of risk and the remarkable difference the voluntariness of risk poses in the subjective nature of "acceptable risk."

5.1 Risk-Benefit Model

To better explain the role of an RBA here: much bioethics commonly uses some version of

principlism, from the Nuremberg Code [1948] through Beauchamp and Childress' influential textbook [1977], to the official Belmont Report [1979]. Typical statements of principlism assert that medical professionals must uphold nonmaleficence, beneficence, autonomy, justice, and other relevant principles in their work, while following sometimes-complicated recipes to resolve conflicts among those principles in difficult cases. This complexity partly exists because new cases—especially involving novel technologies—challenge common interpretations of how to apply the principles, as well as the usefulness or even the validity of the principles themselves.

In particular, standard applications of these principles are often rooted in certain presuppositions about the limitations and features of the human brain and mind, and these presuppositions are upended by emerging human enhancement technologies. For example, to force prisoners of war to stay awake for 48 consecutive hours would seem to be unethical and illegal: for normal humans with normal brains, such actions are torturous. But it may not be objectionable to employ a drug that safely enables a soldier to stay awake and alert for that duration, e.g., for standing guard or in actual combat.

Moreover, where the traditional focus of bioethics is on the welfare of the individual, in a military setting, the welfare of the individual legitimately may be subordinated to the interests of the unit, the mission, or the state; and so we need something else to reconcile any discrepancies between the two. In the following, we propose that a risk-assessment approach can serve as a useful instrument in the larger ethical toolbox.

Bioethical dilemmas, then, are exacerbated when core principles come into conflict, or when exact consequences or circumstances of application are uncertain. Under these conditions, it is reasonable to turn to an RBA, sometimes understood as a form of cost-benefit analysis, as a way to assess the permissibility of possible actions. The Belmont Report had such concerns listed as desiderata under the principle of beneficence (and nonmaleficence):

> Assessment of Risks and Benefits
> 1. The nature and scope of risks and benefits.
> 2. The systematic assessment of risks and benefits [National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research 1997].

But the vagueness of these terms is a recurrent problem in bioethics. While more rigorous RBA is widely used in policymaking, such as evaluating the impact of engineering projects, it may be unfamiliar territory for bioethicists and thus worth explicating here.

"Risk" is an unavoidable concept in the ethics and policy of military enhancement, yet the term is often used much too loosely. Without a clear understanding of the range, quality, quantity, diversity, or other aspects of the risks at hand, it would be difficult to arrive at practical guidance for future action. So let us examine the concept more closely: The risks we address herein are primarily related to harmful but *unintended* behavior that may arise from human enhancement in the military. We will describe a fuller range of other risks and issues involving *intentional* harm in the course of the conduct of war later. Also, while much of the literature's discussion of risk deals predominantly with harms to the individual warfighter [Lin, Bekey, and Abney

2008; Wang 2008], we expand their range here to include possible harms to others.

Following such discussions, let us first define risk simply in terms of its opposite: safety. Risk is the probability of harm; and safety is the degree of freedom from risk. Safety in practice is merely relative, not absolute, freedom from harm, because no activity is ever completely risk-free. For instance, even a training run raises the risk of heat stroke or heart attack; taking aspirin raises the risk of blood not clotting properly or stomach bleeding, even if it lowers the risk of heart attack. Many risks are uncontroversially worth taking, but how can we determine that?

It may help to recognize that risk can be understood in at least four distinct ways. Following on the work of Sven Ove Hansson [2004] and Fritz Allhoff [2009], we can first understand a "risk" as a chance of some unwanted event, or lack of a wanted event, which one is uncertain will occur. If instead an enhancement definitely had some specific impact, such as causing all such patients to die within a year, then it would be more appropriate to term it a "consequence" of that enhancement, rather than a risk: uncertainty is one of the features of risk.

Second, we can understand a risk as the cause of an uncertain but unwelcome event, or of the possible nonoccurrence of a desired event. A human enhancement may cause an inability to sleep, or sexual dysfunction, or decreased inhibitions and resultant inappropriate behavior, or other side effects in a way not perfectly predictable. We sometimes call such statistical causal claims a "risk" of such side effects.

The third conception holds that risk is the numerical probability of an unwanted event, or lack of a wanted event, expressible as a percentage outcome. Imagine that we ask about the risk of an enhancement to have a certain health impact. For example, how likely is it that taking a particular antisleep medication, that enhances alertness, will result in paranoia or seizures? The appropriate answer is stated as a probability, e.g., that the risk is 20 percent according to clinical studies.

Fourth, risk can be understood as a measure of the expected outcome of unwanted, or lack of wanted, events; this is best understood for groups of events, rather than for a single instance. So, imagine that there are 1,000 soldiers who will be given a new mind-altering biotechnology designed to increase their ability to process information and decrease their response time during stressful situations, such as battle. Further, imagine that some of the soldiers will have adverse reactions to the enhancements and be paralyzed as a result. We do not know which soldiers will be paralyzed, but given previous studies or clinical trials, we estimate a rate of 15 percent. The risk, then, is 150 out of the 1,000 soldiers, in the sense that we expect that number of soldiers to become paralyzed due to the biotechnological intervention.

These last two ways of understanding risk are more quantitative, as opposed to qualitative. The third sense of risk gives us the likelihood that something will happen, usually expressed as a percentage; whereas the fourth sense gives us an expected outcome, usually in terms of some number of valued entities lost, or some number of valued entities that we fail to gain, or some number of disvalued entities gained. This fourth sense of risk is the most common sense of "risk" in professional risk analysis. In particular, this concept of "risk" can be defined as "a numerical representation of severity, that is obtained by multiplying the probability of an unwanted

event, or lack of wanted event, with a measure of its disvalue" [Allhoff 2009].

In the example above, this definition of risk plays out as follows: the percentage risk (sense three) of death is 15 percent for the intervention. The disvalued entities gained are human deaths; in this example, their value is absolute, resulting in multiplying 15 percent by the relevant population (1,000 soldiers) to generate the defined fourth sense of expected risk, or 150 deaths.

The concept also applies to other, different measures of (dis)value besides death. For example, suppose a new virus was developed that enhanced warfighter muscle strength in a way that is worth $10,000 per soldier, but caused 20 percent of the soldiers to develop a severe flu, requiring $5,000 in direct and opportunity costs. Then the expected risk (and benefit) can be expressed in dollar terms: so, in sense four, the expected risk is 20 percent times $5,000, or $1,000 per soldier; the expected benefit is $10,000 per soldier; so the expected net benefit is $9,000 per soldier.

In RBA, it is this fourth conception of expected value that is often the most interesting to decision-makers [Sen 1987]. That is, what people usually most want to know is the expected value of the result, sometimes conflated with the "expected utility." This allows a quantitative assessment of both risk and benefit in a way that gives a clear numerical answer for a course of action—a "decision algorithm" of sorts. For example, we could decide that causing paralysis to 150 soldiers is unacceptable, and demand changes to the bioenhancements to make them safer before they are used. But if the expected loss can be reduced to, for example, 0.5 percent—that is, we expect five soldiers out of 1,000 to be paralyzed as a result—we may deem the enhancement "safe enough" to use. Such judgments are routinely made for vaccines and other public health interventions that bear some risk for the individual while enhancing the whole. Such judgments are also routine for commanders of troops in wartime, assessing whether particular tactics in battle are too risky or not.

But of course, while this sense of risk as expected value may be desirable for policymakers, it often greatly oversimplifies the intractable problem of ascribing mathematically exact probabilities to all the undesired outcomes of our policies. It often suggests an aura of false precision in ethical theorizing. It also ignores a common issue concerning risk assessment in bioethics: the distinction between "statistical victims" and "identifiable victims." RBA might well assert a statistical certainty that we would save more lives (or quality-adjusted life years or whatever the unit of assessment) by diverting money we would spend on "last-chance treatments" to instead campaigns to, say, prevent smoking.

But the "rule of rescue" [Jonsen 1986] and related ethical rules of thumb rely on the idea that we actually value saving identifiable lives more than statistical lives. That is, we tend to care more about using every last measure to save Grandma from her stage IV cancer than to save many more lives of future strangers. Or, in the military, an individual may unquestioningly risk his future well-being and even his entire unit in the mad dash to rescue a wounded brother-in-arms, in a way that RBA would consider irrational but in fact may result in a medal of valor, even if posthumously awarded. As long as the difference in our moral attitudes toward statistical victims and identifiable victims is defensible, attempts to use RBA are problematic at best.

What then can we say for certain about risk, especially with respect to military enhancement? How can we answer the question of determining acceptable risk? We can begin by seeing that risk and safety are two sides of the normal human attempt to reduce the probability of harm to oneself and others, even as we are often unsure of the exact probabilities involved. To make things even more difficult, war is a strange human activity, not least because it reverses this tendency: in war, one ordinarily wishes to increase the probability of harm to one's enemies. But the laws of armed conflict and the typical rules of engagement make clear that not all ways of increasing risk for one's enemy are morally legitimate; and some ways of increasing risk for one's own side may be morally legitimate and even morally required. These facts considerably complicate the ethics of risk assessment for military human enhancement.

5.2 Risk Factors

In the absence of precise probabilities, can we say anything useful about how to determine whether or not particular enhancements pose an acceptable risk or not? Perhaps some further conceptual clarification will help.

A. Consent or Voluntariness

To begin, the major issues in determining "acceptable risk" include, but are not limited to, the following five factors [Lin et al. 2008]:

Consent: Is the risk voluntarily endured, or not? For instance, secondhand smoke is usually considered more objectionable than firsthand, because the passive smoker did not consent to the risk, even if the objective risk is smaller. Will those who are at risk from military enhancements reasonably give consent? When, if ever, would it be appropriate to engage in enhancement without consent of those affected?

Morality ordinarily requires the possibility of consent: to be autonomous is, at minimum, to have the capacity to either give or withhold consent to some action. But warfighters often have no choice about substantial parts of their roles and duties; once an individual has volunteered for service, military ethics accepts that many choices open to civilians are no longer options for military personnel. But which choices exactly, i.e., under what circumstances could an enhancement be required for warfighters?

B. Informed Consent

Another possible problem is the uncertainty or unpredictability arising from enhancements: Will they actually work as promised? Even if they do, will the enhancements have unintended consequences or side effects? This leads to a second aspect of consent, familiar from the bioethics literature:

Informed consent: The worry here begins with the usual requirement in civilian bioethics to inform patients of the details about his or her diagnosis, prognosis, alternative treatment options, and side effects of each alternative, before treatment is morally permitted. For enhancement ethics, this is already problematic: a "diagnosis" is commonly understood as a physician's theory of what ails a patient, but nothing ails the soldier undergoing enhancement; enhancement is typically understood to stand in contrast to therapy [Allhoff et al. 2010a]. Instead, the "diagnosis" refers to whatever ability the enhancement is intended to improve or optimize—possibly regardless of its effect on the

rest of the warfighter's life. The "prognosis" then refers to the expected future with respect to that ability given the enhancement, versus the expected future without it; only if alternative enhancement treatments are offered would further alternatives be relevant to discuss. And if the enhancements are given prior to the completion of clinical trials, the side effects may be merely speculative, or even completely unknown. Are warfighters entitled to all of this information before they consent to enhancement, if their consent is indeed required?

There is yet a further risk factor that falls under "informed consent", though not to the warfighter but to other people. Is the risk—of enhancement malfunction, increased probability of disproportionate violence or even war crime, or other harm—by enhanced warfighters to enemy combatants required to be disclosed? Under usual interpretations of the laws of armed conflict, there is no general "duty to disclose" the nature of one's attack upon one's intended target, as long as it adheres to principles of discrimination and proportionality; surprise is well understood as a legitimate tactic in war.

But neuroenhancements may pose novel difficulties if they increase risk to unintended targets—the noncombatants, specifically, the civilian population of the enemy, or even of neutrals or one's own population while housing and training enhanced warfighters. Is it morally permissible to have enhanced warfighters who pose a risk to civilian populations without informing the populations of the risk? For example, suppose warfighters take drugs or other psychological enhancers that reduce inhibitions and fear in order to enhance battlefield performance, but in a civilian setting, these drugs cause more traffic accidents. This is reported to be exactly the risk with toxoplasmosis, a parasitic infection of interest to the military [Sapolsky 2009].

C. Affected Population

This leads us to consider that even if consent or informed consent for the warfighter is not morally required for enhancements, we may need to focus on the affected population as another factor in determining acceptable risk:

Affected population: Who else is at risk, besides the enhanced soldiers themselves—does it include groups that are particularly susceptible or innocent, such as the elderly or young children, or merely those who broadly understand that their role with respect to enhancements is risky, even if they do not know the particulars of the risk? In military terms, civilians and other noncombatants are usually seen as not morally required to endure the same sorts of risks as military personnel, especially when the risk is nonvoluntary or involuntary. Will the use of military neuroenhancements pose the risk of special, unacceptable harms to noncombatants?

An immediate issue pertains to the reliability of military neuroenhancements: Will they degrade over time or have side effects that only slowly come to light? Will they be easily reversible upon re-entry into civilian life, or will their effects be permanent? Will they have vast and/or unpredictable differences between different human subjects? Will they exacerbate underlying physical or psychological problems, and potentially cause physical or psychological difficulties for the loved ones, friends, family, and communities of enhanced soldiers?

For instance, any neuroenhancements that increase aggression may then cause warfighters to attack indiscriminately or disproportionately,

similar in effect to landmines as well as nuclear, biological, and chemical weapons, and likewise would be immoral to deploy. Even worse is when enhancements foreseeably may cause damage outside a combat zone, e.g., in ordinary interactions with shopkeepers, friends, or family.

D. Seriousness and Probability

We thereby come to the two most basic facets of risk assessment: seriousness and probability, that is, how bad would the harm be, and how likely is it to happen?

Seriousness: A risk of death or serious physical or psychological harm is understandably seen differently than the risk of a scratch or a temporary power failure or slight monetary costs. But the attempt to make serious risks nonexistent may turn out to be prohibitively expensive. What, if any, serious risks from military neuroenhancements are acceptable—and to whom: soldiers, noncombatants, one's family, the rest of one's environment, or anything else?

Probability: This is often conflated with seriousness but is conceptually quite distinct. The seriousness of the risk of a 15-km asteroid hitting Earth is quite high (possible human extinction), but the probability is reassuringly low (though not zero, as perhaps the dinosaurs discovered). What is the probability of harm from military neuroenhancements? How much certainty can we have in estimating this probability? What probability of serious harm is acceptable? What probability of moderate harm is acceptable? What probability of mild harm is acceptable?

E. Who Determines Acceptable Risk?

In all social theorizing, the understanding of concepts retains a certain degree of fluidity, dependent in part upon how those in power or epistemic authority determine their meaning. The concept of risk, which includes psychological, legal, and economic considerations as well as ethical ones, is certainly no different. Hence, the concept of an acceptable risk—or an unacceptable one—is at least in part socially constructed. In various other social contexts, all of the following have been defended as proper methods for determining that a risk is unacceptable [Lin, Bekey, and Abney 2008]:

Good-faith subjective standard: Under this standard, it would be left up to each individual to determine whether an unacceptable risk exists. That would involve questions such as the following: Can soldiers in the battlefield be trusted to make wise choices about acceptable risk? The problem of nonvoluntary risk borne by civilian noncombatants makes this standard impossible to defend, in addition to the problems raised by the idiosyncrasies of human risk-aversion and the requirements of the chain of command and the reasonable expectation that orders will be carried out.

The reasonable-person standard: An unacceptable risk might be simply what a fair, informed member of a relevant community believes to be an unacceptable risk. Can we substitute military regulations or some other basis for what a "reasonable person" would think for the difficult-to-foresee vagaries of conditions in the field and the subjective judgment of soldiers? Or what kind of judgment would we expect enhanced warfighters to have: would we trust them to accurately determine and act upon the assessed risk? Would they be better—or worse—than an "ordinary" soldier in risk assessment? Would their enhanced powers distort their judgment?

Evidence- based standard: An unacceptable risk requires evidence (and usually expert testimony) as to the reality and unacceptability of the risk. But there is still the first-generation problem: how do we understand that something is an unacceptable risk unless some first generation has already endured and suffered from it? How else could we obtain convincing objective evidence?

With regards to the military use of neuroenhancements, the second standard is most often defended in law and practice. The third standard may seem preferable, given the vagueness and uncertainty of what constitutes a "reasonable person", but it does have the serious first-generation problem. One solution could be a hybrid of the latter two principles: to assert an ethical obligation for extended testing of enhanced warfighters in a wide range of simulated or controlled environments before risking dangerous interaction between the enhanced and unenhanced. This testing must be thorough, extensive, realistic, variegated, and come in stages, so that full deployment with possible or actual civilian contact comes only at the end of a long training regimen and safety inspection.

From the risk-reward perspective of RBA, it may very well be acceptable to deploy enhanced warfighters as soon as such extensive testing indicated their mistakes and other risks were, on average, no worse than that of the typical human soldier.

F. Precautionary Principles

It should be noted that, unlike an RBA, an alternate view of risk is one that ignores benefits entirely: a precautionary principle. Although it has been variously formulated [Allhoff 2009], here is a representative statement of a strong version of the precautionary principle: "When an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically" [Wingspread 1998].

Neuroenhancements that had not been adequately researched may violate this version of the precautionary principle. Such a principle takes the uncertainty inherent in RBA and in effect endorses a kind of "maximin" (or maximizing the minimally acceptable results [Rawls 1971]) mode of assessing acceptable risk: unless we can be sure the worst-case scenario will be acceptable, we ought not to undergo the risk.

But taking this precautionary principle as a blueprint for risk assessment is vastly at odds with standard procedures, not only in the military but also in civilian bioethics. For instance, we do not in fact require that a new vaccine or other medical treatment be guaranteed to produce no deaths or other negative side effects, and the point of clinical trials is to attempt to establish cause-effect relationships, not to completely prohibit use; there are well understood circumstances in which an experimental treatment may be made available before it is fully causally understood and has full regulatory approval. And military necessity is one of those circumstances.

G. Other Risks

A perpetual risk remains with respect to security issues for enhanced warfighters, although the issues here are common to many aspects of technological culture. For example, how susceptible would a enhanced warfighter be to "hacking", e.g., after capture? That is, especially given "arms race" concerns, are there enhancements

that would create a security risk if they fell into enemy hands? For example, suppose we deploy warfighters with enhanced immunity to brain damage or to biological or chemical pathogens that normally disable the brain, such as neurotoxins; if they are captured and thereby have that technology discovered and replicated by a rogue state or terror group, would it unduly risk a biological or chemical attack on our citizens, at no risk to the warfighters themselves?

Besides policy risks, there are also specific legal risks to monitor. Some experts have pointed out that neuropharmacological agents, either enhancing or incapacitating, may violate the Biological and Toxin Weapons Convention and the Chemical Weapons Convention as usually understood. We discussed previously in section 3.1 of this report that the BTWC could be breached in an unusual but nevertheless technically possible: a bioenhanced person or animal could count as a "biological weapon" or "biological agent", since these terms not clearly defined in the agreement.

Some commentators have raised risks of a more abstract sort. For instance, is there a risk of, perhaps fatally, affronting human dignity or cherished traditions (religious, cultural, or otherwise) in allowing the existence of enhanced warfighters or "Supermen"? Do we "cross a threshold" in creating such superhuman warfighters, possibly in a way that will inevitably lead to some catastrophic outcome? Is this "playing God" with human life [Evans 2002]?

What seems certain is that the rise of enhanced warfighters, if mishandled, will cause popular shock and cultural upheaval, especially if they are introduced suddenly and/or have some disastrous safety failures early on. That is all the more reason that a lengthy period of rigorous testing and gradual rollout (a "crawl-walk-run" approach) appears a moral minimum for the ethical deployment of enhanced warfighters. Further, this points to the early, prior need to identify a full range of possible ethical, technological, and societal issues of military enhancements in order to better account for risk.

6. A Hybrid Framework

To evaluate the propriety of military human enhancements with respect to subjects themselves, prior to their use in combat, bioethics would seem to offer the right standards to apply; but we have noted important gaps in the research, medical, and public-health frameworks as they apply to a military context. While a risk-assessment model is informative and complementary, it too does not capture the unique conditions and considerations of a military context. To fill that gap, we offer a hybrid model that integrates relevant aspects from bioethics and risk assessment—a new framework that can help address the broad range of ethical, legal, and social issues previously discussed.

The use of biomedical enhancements in the military to enhance warfighter performance cannot be ruled out as *a priori* unethical or illegal. As Michael Russo states in connection with drugs to enhance cognition:

> All militaries desire technological, training, and doctrinal advantages so as to increase the probability of success. Each military strives to have a performance edge. The US military, through multiple methods, seeks to optimize cognition so as to provide individuals with a cognitive performance edge. The use of cogniceuticals to provide a cognitive performance edge in military engagements does not appear to cause ethical concerns [Russo 2007, B125].

At the same time, military leaders must strive to act within appropriate ethical norms and legal rules. Doing so would be "right," cause the least amount of harm to the warfighter, and help avoid criticism that could undermine military effectiveness. What follows, therefore, is a proposed set of ethical and legal rules to govern this military practice.

6.1 Legitimate Military Purpose

Enhancements in the military must be used for legitimate military ends. In the first place, the purpose must be military. For example, it would be unethical to give warfighters enhancements to enable them to excel at activities while on leave, assuming this could not be justified as boosting warfighter morale or self-confidence.

Furthermore, the military purpose must itself be legitimate. So it would be unethical to give a warfighter an enhancement to increase the effectiveness of the unit if the unit's mission is illegal. As Rhodes observes, "the group does not constitute its own purpose. Under JWT [just war theory], military organizations exist to defend some greater good … The good of the nation is both logically and morally distinguishable from the well-being of the military unit in the same way that the good of a patient is logically and morally distinguishable from the good of a physician" [Rhodes 2009, 55].

6.2 Necessity

The enhancement not only must be used to help achieve a legitimate military objective, but its use to achieve the objective must be reasonably necessary. Childress describes necessity as a lack of acceptable alternatives, while Gross states that "the simplest way to determine excessive harm is to ask whether military planners have less costly, alternative means at their disposal to achieve the same goal" [Gross 2006, 62]. A more precise way of establishing that the use of an enhancement is necessary is to show that there is no other means of achieving the objective that offers a better ratio of risks to benefits.

Military necessity may not be clear cut, however, and reasonable minds may disagree on when it exists. As Hilary Jaeger emphasizes, "it is very easy to blur the line between operational necessity and administrative convenience" [Jaeger 2007]. Russo gives the following example of uses of cognition-enhancing drugs that would and would not meet the standard of military necessity: "If cogniceuticals were developed that specifically suppressed appetite, and considered for use in soldiers as a substitute for providing and carrying meals, that would constitute an unethical application of cogniceuticals with regard to necessity. However, if a soldier found him/herself without food for unanticipated or unintended reasons, the use of an appetite suppressant would not necessarily be unethical" [Russo 2007, B122].

Without further elaboration, Russo's position seems unacceptable; warfighters might be much better off, at least for limited periods of time, if they did not have to carry the weight of their food. Russo takes a more persuasive approach when he considers whether it would be justifiable to provide the pilots of troop transports with alertness-enhancing agents and concludes that in most instances it would not be since there could be alternatives such as getting more sleep or alternating with a more rested crew member [Russo 2007, B124].

6.3 Benefits Outweigh Risks

Not only must the use of an enhancement be necessary in the sense that there are no less costly means of achieving the legitimate military objective, but the benefits of giving the enhancement to warfighters, which can accrue to the unit, the mission, and the state as well as to the warfighter him- or herself, must be greater than the risks to the warfighters and noncombatants. This principle may be thought of as an aspect of proportionality, a concept that is at the heart of military ethics and one of the main determinants of when and how much armed force may be used. As Gross states, "necessity remains constrained by proportionality" [Gross 2006, 61].

The risks that are assessed here are net risks, i.e., expected value or expected utility; they are the risks from using the enhancement minus the risks of not using it. For example, following our above analysis, it seems permissible to give a warfighter an enhancement that has a 20 percent chance of causing serious adverse health effects if, with the help of the enhancement, the warfighter is able to accomplish a mission so much more efficiently that it reduces by an equal or greater amount—say, 30 percent—the chances of suffering comparable ill health effects from being seriously injured.

As mentioned previously, one difficulty lies in how values are assigned to benefits and risks. If risks are valued the way they are in the medical

model, then they would have to be measured subjectively, in terms of the individual warfighter's characteristics, preferences, and aversions. A 20 percent risk of painful headaches, for example, will be more abhorrent to some people than to others according to their tolerance for pain. But the "good faith subjective standard" and resulting subjective measurement, as discussed previously, would be tantamount to giving the warfighter the right to consent, since it is difficult to imagine any other way of identifying and measuring risks from the individual warfighter's perspective. Since as discussed below, individual consent is neither practical nor ethically or legally required in most cases, risks will have to be estimated more objectively.

Furthermore, the benefits to a unit, mission, or nation may be hard to measure, much less to quantify precisely. This is a problem that extends beyond the ethics of biomedical enhancement use. Whenever warfighters are sent into battle, they risk death and painful, disabling wounds, so it might seem that any combat situation can be deemed to offer sufficient benefits to outweigh the direst of risks.

But the welfare of the individual warfighter, while not the primary consideration as it is in the medical model, is still important for many reasons, including acting ethically, maintaining morale and order, encouraging continued enlistment and re-enlistment, and avoiding rendering the warfighter *hors de combat*. So it would be wrong to place warfighters in danger for little or no gain, an accusation lodged, for example, against many of the attacks along the Western front in World War I.

Another issue that bears on the use of enhancements is how great the risks can be from enhancements that an individual warfighter is required to take, or how great the acceptable risks imposed on noncombatants. A similar question arises in combat when commanders must decide whether to attack a heavily fortified position with less than optimal strength or which warfighters to place in particularly dangerous situations, such as "taking point" or being sent on patrols near or behind enemy lines. In some of these cases, selection may be all but tantamount to a death sentence, yet military ethicists appear to agree that no risk is too great in the sense that there are no circumstances in which it would be permissible. What circumstances would justify extreme risks, however, are not completely clear but will bear on the evaluation of some military enhancements.

At one point, for example, Gross suggests that warfighters can be required to accept any risk, no matter how extreme or unusual, so long as the risk is imposed on all members of the relevant unit rather than on just a few. "Soldiers can accept risk and danger," he says, "provided all face the same threat equally and no one is excused for frivolous reasons … An action becomes supererogatory when the risk it entails is both overwhelming and impossible to distribute equally so that some must assume an unequal burden" [Gross 2006, 111]. Elsewhere, however, Gross states that "we cannot kill our soldiers, if by that we mean not to simply risk their lives, but willfully cause their deaths.

The line is fine but not merely semantic. Soldiers lose their right to life vis-à-vis an enemy. The enemy can kill them but their own commanders cannot … Compelling soldiers to act in the face of certain death … is to murder them. For this reason, they must consent and, as it were, sacrifice themselves. For this, they deserve a medal" [Gross 2006, 110-111]. This statement suggests that some risks are so dire that warfighters

would have to consent to bear them even if the risks were shared by everyone.

We will return again to the issues of consent and fairness shortly. But asking how much risk warfighters can be forced to accept raises the question of whether there are certain kinds of enhancements that should be out of bounds for the military even if warfighters were willing to take them voluntarily. Certainly the objection cannot be made that all transformative biomedical enhancement should be prohibited, since transforming recruits in ways that improve their military capabilities is the purpose of military training, which forms a large part of military life.

As Rhodes observes, "Basic training is only the tip of the iceberg. Technical schools help members gain an initial competence in a given field, but it is every superior's task to help subordinates become ever more capable. Formal professional schools, appropriate to military grade and experience, punctuate a military career. At least in the US military, 10 percent or more of one's career may be spent undergoing formal schooling" [Rhodes 2009, 59]. Indeed, from the Navy's standpoint, "nearly every hour of the day is devoted to an aspect of Naval knowledge and skill development [Williams, Hagerty, Yousha, Horrocks, Hoyle, and Liu 2004]. As for the Army, "organized, systematic physical fitness is a defining element of Army culture. It is the first collective event of the day in every Army unit" [Casey Jr. 2011, 1-3].

The transformation that military training strives to achieve is radical and comprehensive. "Unlike introductory training courses in corporate settings," says Rhodes, "basic military training seeks to create a thoroughgoing change in identity: it aims to change character in ethically meaningful, as well as military useful, ways … Training seeks to change more than what trainees know or can do. It seeks to change what trainees *care* about" [Rhodes 2009, 51]. The Textbook of Military Medicine describes military training as "a monumental process of transforming individual men and women into soldiers, sailors, airmen, and Marines prepared to defend their country … This transformation results from the total immersion of recruits in the basic training environment. Basic training is an intensive, comprehensive process that transforms civilians into service members by inculcating military values and teaching military skills" [Broadhurst, McNeill, Hendrix, Wright, and May 2003, 161].

The training process "begins at the reception battalion, where the recruit is brought under military control, completes entry processing, and begins the basic training process. This initial indoctrination from civilian to military life includes a 'moment of truth.' For example, in the Air Force's version of the 'moment of truth,' all recruits receive a 'shakedown inspection' in their dormitories within 24 hours of arrival. The staff removes all nonprescription drugs, weapons, valuable items, pornography, tobacco, and other contraband from the recruits for the duration of basic training. Any illegal items are disposed of and the rest is returned to the recruit upon departure. All services have similar procedures" [Broadhurst, McNeill, Hendrix, Wright, and May 2003, 165].

After the reception process is over, basic training begins, and recruits are plunged into what for most of them is an alien environment. They live in barracks, which in the Army can be limited per recruit to as little as 62 square feet, a space less than 8 by 8 feet [Broadhurst, McNeill, Hendrix, Wright, and May 2003, 163]. In the Navy, "recruits live in open-bay barracks with a maximum capacity of 88 recruits. Only one sex occupies a

bay. Bathroom facilities are also open-bay style. Bed linens are changed weekly. Showers are required once daily. Shoes or shower flip-flops are required to be worn at all times except when in bunks. The recruits do everything as a large group: they eat together, shower at the same time, and sit in class together. They can march up to 25 miles a week traveling across the base to go to classes and meals [Broadhurst, McNeill, Hendrix, Wright, and May 2003, 164].

Training also can be dangerous. "Recruit training is a specific, controlled situation in which young men and women are exposed to stress. Inherent in recruit training are multiple sources of stress, including dramatic changes in living arrangements, separation from readily available and usual social supports, and intensive physical and emotional challenges" [Williams et al. 2004, 814].

Training-related injuries are the leading cause of clinic visits in the military [Bullock, Jones, Gilchrist, and Marshall 2010]. They can be deadly; during the period 1977-2001, 139 of 199 nontraumatic recruit deaths during basic training were caused by exercise [Scoville, Gardner, Magill, Potter, and Kark 2004]. Injuries from excessive training occurred in 75 percent of the men and 78 percent of the women completing US Army basic combat training [Evans, Reynolds, Creedons, and Murphy 2005]. In the Navy, 36 percent of female Navy recruits suffered overuse injuries in basic training [Roy, Springer, McNulty, and Butler 2010]. The risk of harm is exacerbated by the use of physical fitness training as a method of behavioral control: "The common military practice of utilizing physical exercise as a punitive, corrective, or motivational tool has the potential to lead to overtraining due to its unpredictable frequency and volume …" [Bullock, Jones, Gilchrist, and Marshall 2010, S166].

Training also is a medium for competition. Rhodes notes that "commanders are encouraged to meritoriously promote recruits who have consistently demonstrated superior performance in the areas of physical fitness, marksmanship, leadership, motivation, and academics" [Rhodes 2009, 170-171]. Even the basic Army Physical Fitness Test, "originally intended to ensure that soldiers possessed a basic level of fitness," has become competitive: "The number of total points achieved on the APFT can be used to tier soldiers competitively for promotions, service schools, and other selection processes" [Evans 2005, 1005]. Competition for recognition and promotion in turn leads to excessive training and harm. "In classic military tradition … efforts to exceed the standards and/or execution of training errors have contributed to the injury epidemic present today" [Bullock, Jones, Gilchrist, and Marshall 2010, S165].

In short, aside from employing somewhat different technologies, biomedical enhancement has at least some of the same objectives as classic military training. Given how intense, transformative, and potentially dangerous military training is, parity of reasoning would indicate that there is no reason to prohibit the use of all enhancements. If there were a reasonably safe and effective pill that would produce the same or better results than certain modes of training, it is difficult to see what would be wrong with it.

In the wider debate on performance enhancement in general, three types of enhancements cause particular concern: enhancements that blend human and animal DNA; germ line changes, that is, enhancements that would be passed on genetically to the warfighter's descendants; and enhancements that diminish an individual's capacity to make moral judgments. With today's technology, it is not possible to

manipulate an adult's germ line intentionally, but as technology improves, this is an issue that deserves further discussion.

Enhancements that impair moral judgment were mentioned earlier; some say that warfighters should not be given beta blockers or similar drugs in an effort to prevent them from suffering PTSD since doing so could reduce their moral sensibilities [Wolfendale 2008; Henry, Fishman, Youngner 2007]. Given the importance of individual moral reasoning in ensuring that warfare conforms to ethical and legal norms, this seems like an appropriate restriction.

A ban on blending animal and human DNA is less compelling. People worry about creating creatures that are more than animals but less than human, like Dave, the part-human, part-chimpanzee character in Michael Crichton's book *Next*, but this would not seem to be enhancement but diminishment, and in any event, military interest in high-functioning non-humans is likely to be met by the use of robots. Leon Kass, the former chair of President Bush's Council on Bioethics, is worried that we will lose our appreciation for what it means to be human: "Most of the given bestowals of nature have their given species-specified natures: they are each and all of a given *sort* …. We need more than generalized appreciation for nature's gifts. We need a particular regard and respect for the special gift that is our own given nature" [Kass 2003, 1; emphasis in original]. But it is not clear what serious, negative consequences Kass has in mind.

6.4 Dignity is Maintained

Character and integrity are crucial for the proper functioning of warfighters. Both for maintaining an *esprit de corps*, and for the best military results, warfighters need to experience themselves as being part of a larger community, with a purpose that transcends themselves. To maintain such a sense of mission requires that the warfighters not feel as if they are mere tools, mere instruments, but are being treated with dignity and respect.

Michael Gross emphasizes the need to avoid humiliating warfighters. "Ordinarily," he says, "any violation of self-esteem and its derivative principles prohibiting torture, humiliation, and degradation is unacceptable and morally wrong" [Gross 2004, 56]. He is addressing the treatment of prisoners and enemy combatants, but his admonition applies to our troops as well, since "dignity … protects individuals from humiliation, dishonor, ill-treatment, and servitude" [Gross 2004, 45].

Biomedical enhancements that seriously compromised the user's dignity therefore should be avoided. This would bar enhancements, for example, that produced bizarre or repugnant effects, such as severe disfigurement or undignified behavior.

6.5 Burdens Are Minimized

In line with one of the principles of classic medical ethics, the burdens that an enhancement imposes on the warfighter must be minimized. One implication is that, if possible, any effects likely to cause the warfighter discomfort or distress should be temporary or readily reversible. No one seriously questions the ethics of external "enhancements" (or tools), such as body armor, in part because they are readily reversible: one can simply take them off when they are it is no longer needed or wanted.

Reversibility is especially important if the adverse effects, unless reversed, would continue to affect the warfighter after leaving the military and would also impact people outside of the military, such as family members and other civilians, who do not volunteer for military service the way the warfighter does. As one group of experts in military training observes, "optimal performance during battle and deployment must be balanced against health and sustainable social functioning upon re-entry" [Jonas, O'Connor, Deuster, Peck, Shake, and Frost 2010, 9].

6.6 Consent

As noted earlier, the consent requirement that is such a central feature of both medical and research ethics is largely absent in the military. Gross states, for example, that "military medical ethics only *permits* informed consent, and thereby reverses the burden of proof generally incumbent on medical personnel. During war those seeking informed consent must explain how it does not impair the functioning of military operations and why they simply do not command their troops to follow an order" [Gross 2004, 107].

In Gross' opinion, the lack of emphasis on autonomy in military medicine is part of a wholesale inversion of medical ethics: "In peacetime, those *violating* patient rights must justify their action; during war, those *upholding* patient rights generally bear the burden of proof" [Gross 2004, 107]. So, for example, Gross states that "the use of investigational drugs—that is, unproven drugs that provide a therapeutic benefit and maintain the fitness of a fighting force—does *not* meet the conditions requiring informed consent. Although their risks might be very high, investigational drugs do not demand consent if the risk is militarily necessary and is distributed fairly" [Gross 2004, 111].

Gross' position may be confused. Drugs are "investigational" because there is inadequate evidence that they provide "a therapeutic benefit" and maintain "the fitness of the fighting force," not vice versa. Moreover, a drug cannot be both unproven and therapeutically beneficial. But Gross clearly thinks that it is permissible to give warfighters *in the field* drugs like PB and BT vaccine without their consent.

From other statements of his, however, it seems that he thinks that warfighters may not be used as *subjects in military medical experiments* without their consent: "Testing experimental drugs to enhance general human knowledge presents a different sort of problem, particularly during war … [E]xperiments distribute risk unfairly and, therefore, demand informed consent" [Gross 2004, 112]. It sounds like the difference in Gross' mind between distributing "investigational" drugs to troops in the field and conducting experiments is that experiments only impose risk on a subset of troops, those who serve as subjects. This makes experimentation, in his judgment, "simply another form of action above and beyond the call of duty" [Gross 2004, 114].

But to repeat the words of the Belmont Report, an experiment is simply "an activity designed to test an hypothesis, permit conclusions to be drawn, and thereby to develop or contribute to generalizable knowledge …" [National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research 1979]. There is no reason why an experiment can't be conducted on all of the members of a unit or even on an entire service. It isn't even necessary that some of the subjects serve as a control group, since the study can use what is known as

historical controls, where all the subjects receive the experimental intervention and its safety and efficacy is evaluated by comparing the effects on the subjects with what happened in the past to populations that did not receive the experimental intervention. In short, experiments can be conducted in which everyone shares the risk. In that situation, it remains unclear whether or not Gross would require warfighter subjects to give their consent.

A strong argument nevertheless can be made that warfighters should be asked to give their consent to serve as subjects in studies involving exceptionally risky enhancements, and the argument clearly is even more persuasive if only some of the unit members will serve as subjects. Gross is therefore correct to criticize "experiments testing the effects of LSD, radiation poisoning, or chemical and biological agents of the sort the military conducted on soldiers without informed consent since the end of World War II … [which] singled out soldiers for exceptional risk in experiments [and] whose benefits often elude us today"[Gross 2004, 115].

But when is an enhancement *exceptionally* risky? If a 1980 Army follow-up study of all of the subjects who received LSD in the so-called MKULTRA experiments conducted between 1955 and 1967 can be believed, the medical and mental illnesses found in these individuals were comparable in nature and frequency to those found in the general population [US Army Health Services Command, US Army Medical Department 1980]. So why does Gross include the LSD experiments in his list? Is it because of the publicity?

Gross says elsewhere that "risk alone, even the high risk of an investigational drug, is insufficient to require informed consent from soldiers if medical risk is *no higher than military risk* and distributed fairly among all troops" [Gross 2004, 135; emphasis added]. But what is "military risk"? Wolfendale and Clarke contend that warfighters have the right to withhold consent for "highly unusual" risks. But from whose vantage point do we gauge "unusual"? A commander is likely to be aware of more enhancements than a new recruit, while the general public may find many more enhancements "unusual" than a DARPA program officer.

Fitzpatrick and Zwanziger propose as a remedy for these uncertainties that before people enlist, they should be given a general idea of the types of risks that they may encounter in the military, including the risk of being given experimental drugs. If they don't want to take these risks, they simply can decline to enlist. Conversely, by enlisting, they can be deemed to have consented to the risks.

This notion of "anticipatory consent" is interesting, but it too falls short, since there would seem to be no limit to the dangers that warfighters could be exposed to by their superiors so long as the dangers were generally described to them before enlistment. Telling them in advance that they might lose their lives in combat, for example, does not seem to justify ordering them to undertake suicide missions.

These uncertainties underscore the fundamental point made earlier that the role of consent in the military must be understood as limited. Consent in the military simply cannot do the heavy ethical and legal lifting that is expected of it in civilian settings. For one thing, in many military situations, obtaining consent will be highly impractical. There may not be an opportunity for sufficient conversation between potential subjects and experimenters. As Gross observes, "con-

trolled experiments under battlefield conditions do not require consent. One obvious reason is feasibility. Generally, it is simply impossible to obtain consent" [Gross 2004, 115]. Moreover, the flip-side of consent is refusal to consent, and warfighters are likely to be reluctant to refuse to use a performance enhancement if they think that this would adversely affect other members of the unit, for example, by placing on them more risk or more of the responsibility for carrying out the mission.

More importantly, there is too much doubt about whether a warfighter's consent would ever be sufficiently free of external pressure or coercion to be voluntary. An apt illustration is the consent form that Navy pilots must sign before they are given amphetamines to keep them alert during long missions. The form clearly states that consent is voluntary: "My decision to take Dexedrine," it reads, "is voluntary. I understand that I am not being required to take the medication. Neither can I be punished if I decide not to take Dexedrine" [US Navy 2000]. But the form goes on to say: "However, should I choose not to take it under circumstances where its use appears indicated, I understand safety considerations may compel my commander, upon advice of the flight surgeon, to determine whether or not I should be considered unfit to fly a given mission." In other words, if you don't consent, you may not be allowed to fly. It's hard to imagine that pilots who have devoted so much time and effort to being able to fly in the military would refuse to take the drug.

Another concern arises with warfighters such as special forces personnel who are reported to be willing to do almost anything to give themselves a performance edge. The impediment to choice in their cases is not pressure from their superiors so much as their own internal drive to excel. But here, bioethics takes an interesting turn. Bioethicists generally maintain that there is no need to be concerned about the consequences of harmful decisions that are motivated by internal rather than external pressure [Beauchamp and Childress 1977].

This position stems, it seems, from the recognition that, with the exception of decisions that are purely random, everything we decide to do is dictated at least in part by internal pressures, and in many cases, these pressures can be so strong that the decision-maker may not feel that there is a realistic alternative. Take, for example, seriously ill cancer patients contemplating whether or not to undergo harsh chemotherapy regimens. Bioethicists worry that, if we focused on the pressures and lack of options created by the patients' dire condition, we might not let these patients agree to accept the risks of the treatment, or, in the guise of protecting the patients from harm, might create procedural hurdles that would rob them of their decision-making autonomy.

But even if we accepted this argument, it would not mean that we should be indifferent to the dangers that warfighters may face because they feel overwhelming internal pressure to consent to use risky enhancements. Whether because of the internal pressures that warfighters experience, the external pressures to which they are vulnerable, or simply the practical realities of military operations, consent in the military cannot eliminate the need for ethical and legal oversight.

This oversight can be provided in part by military physicians, who are in the best position to perceive enhancement risks, and who may retain enough of their sense of medical professionalism to give due regard to the welfare of the individ-

ual warfighter. As Hilary Jaeger recommends, "the military physician must act as a counterweight, by being the voice of caution" [Jaeger 2007, B130]. "As a minimum," she explains, "physicians who are asked for their advice or to prescribe medication directly must not only inform all involved of what is known and not known of the risks and benefits of each course of action, but must educate them on the known inherent biases in human decision making. Military physicians … should not hesitate to challenge when they are not satisfied" [Jaeger 2007, B130].

Another option could be to establish an independent group of experts in law and bioethics, similar to the NIH's Recombinant DNA Advisory Committee (RAC), with the necessary security clearances and the responsibility to review and approve formal military enhancement experiments, enhancement research programs such as DARPA's, and, if military necessity permits, proposed deployment uses of enhancements. This would enable a "crawl-walk-run" approach to enhancements with unusual or unknown risks, allowing for an objective or more careful assessment of their permissibility.

6.7 Transparency

No doubt one of the main reasons that the Army LSD and radiation experiments have been so heavily criticized is their secrecy. National security certainly may require that enhancement experimentation and use be kept secret from adversaries, but to the extent consistent with security concerns, the military should inform the public about enhancement research and deployment, including the reasons why the military believes that the risks of the experiment or use are outweighed by the known or potential benefits.

At the very least, as we proposed above, relevant information should be made available to third-party assessors with the necessary security clearances, ideally an independent group of experts in law and bioethics, rather than merely military brass. This would also help reinforce the important principle of civilian control over the military. Further, making military enhancement part of the public record would help sustain Fitzpatrick and Zwanziger's argument in favor of anticipatory consent, since recruits would be more likely to have heard about it before they enlist. Public awareness also could stimulate an open discussion about the ethics and legality of military enhancement that could reduce public opposition.

6.8 Fair Distribution of Risks & Benefits

As discussed previously, numerous commentators object to imposing risks on only a few individuals in the military. Similar ethical objections can be asserted against singling out a few warfighters to receive enhancement benefits. The best approach is to spread risks and benefits as widely as possible. But what if there weren't enough risks or benefits to go around? For example, what if the supply of enhancements were limited, for example, because of manufacturing difficulties or regulatory obstacles? Arguably commanders should be allowed to distribute enhancements to certain individuals for good reason, for example, because their inherent talents made them less able than others or because only they were going to be placed in harm's way. If there were no valid substantive reasons for selecting one individual to receive enhancements over another, the fairest method

of selection would be by lottery [US v. Holmes 1842].

Another concern raised by selective distribution of enhancements is the unfairness that would result if the improved performances that such enhancements made possible led to promotions or other advantages for the users. If everyone cannot have access to beneficial enhancements, a strong argument can be made that accomplishments produced in large part by enhancements should not count favorably. On the other hand, if the enhancement in question comes with significant risks, those who volunteer to accept the risks may be entitled to corresponding benefits as recompense.

6.9 Superiors Are Accountable

In view of the potential for superior officers to bully warfighters into taking unduly risky enhancements, the system by which the military holds superiors accountable for unreasonable acts must keep a lookout for unethical or illegal command decisions concerning enhancement use.

……

How this hybrid framework above is actually implemented to evaluate military enhancements, of course, will need more explication. It should be clear that such an evaluation will be complex, given the wide range of possible enhancements and their contexts of use. Even if this framework is used as a general guideline or checklist for evaluating enhancements, it is difficult to determine whether some of the factors above, such as maintaining the warfighter's dignity, are satisfied. So more work is needed, since "the devil is in the details," as the saying goes. But now we have a more reflective starting point—tailored to the unique considerations associated with the military—to further evaluate the use of military enhancements.

7. Other Considerations

In the above, we have identified key challenges related to ethics, law, and policy that military human enhancements may pose. But the discussion does not end here. In this section, we will briefly discuss other considerations, including philosophical, psychological, and civil-military issues. This is not to say that such issues are unimportant, but only that they would not as likely lead to the kind of direct, physical harm to subjects, as well to other combatants and non-combatants, that are typically the focus of weapons and research evaluations.

We separate these considerations from the preceding discussions to prevent our hybrid framework from becoming more complex than needed at this time. International and domestic law—including bioethics—demand immediate attention, given that they may carry serious sanctions and have a directly humanitarian point. But as only an initial sketch, our hybrid framework certainly can evolve and account for other considerations, such as the following.

7.1 Character and Virtues[8]

Ethics is and must be more than a mere risk-benefit analysis. Sometimes, what is right cannot be found in numbers alone. Values and rights, for instance, are difficult to quantify and weigh against other values and rights, as part of a risk-benefit calculus. We have already seen some of these less-tangible considerations in our previous discussion about bioethics, e.g., that patient autonomy ought to be respected (to varying degrees, depending on the bioethical model). In this section, we will examine other ethical considerations—of character and virtues—traditionally unaccounted for in both bioethics as well as risk-benefit assessments, but nevertheless salient to a wider discussion about enhancing humans. Indeed, our hybrid framework mentions character in the context of a warfighter's dignity, but we will develop the concept further here.

In recent decades, virtue ethics has enjoyed a broad resurgence of interest by scholars, applying the Aristotelian moral framework to environmental ethics, business ethics, bioethics, medical and legal ethics [Oakley and Cocking 2001; Sandler and Cafaro 2005; Walker and Ivanhoe 2007]. Virtue ethics is often thought of as uniquely suitable for professional ethics, so given that the military is one of the professions, it should not surprise us that virtue ethics has been recognized as having core applications here as well. Indeed, virtue ethics has arguably been an integral component of thinking about military ethics for millennia, insofar as reference to virtues (e.g., courage, honor, loyalty, and justice) is an enduring feature of ethical discourse in the military tradition [Olsthoorn 2010].

Virtue ethical frameworks are also being applied to the unique ethical challenges presented by emerging military technologies, such as autono-

[8] We thank Prof. Shannon Vallor for her discussion in this section.

mous robots and drones [Lin, Abney, and Bekey 2012; Enemark forthcoming]. We can extend that trend to consider the ethical implications that military enhancements may have with respect to the moral virtues. First, let us briefly clarify what we mean by "virtues" in the ethical context that concerns us here. In most ethical theories in which virtues play a central role, moral virtues are understood to be states of a person's character: stable dispositions that promote that person's reliable performance of right or excellent actions. Such actions, when the result of genuine virtue, imply the praiseworthiness of the person performing them. In human beings, virtues of character are not gifts of birth or passive circumstance; they are cultivated states that lead to a person's deliberate and reasoned choice of the good. They result from habitual and committed practice and study of right actions, and they imply an alignment of the agent's feelings, beliefs, desires and perceptions in ways that are consistently found to be appropriate to the various practical contexts in which the person is called to act.

Thus virtues of character are conceived as personal "excellences" in their own right; their value is not exhausted in the good actions they promote. When properly integrated, individual virtues contribute to a moral agent's possession of "virtue" writ large; that is, they motivate us to describe a person as virtuous, rather than merely noting their embodiment of a particular virtue such as courage, honesty or justice. States of a person's character contrary to virtue are characterized as vices, and a person whose character is dominated by vice is therefore appropriately characterized as vicious.

A virtuous person is not only conceived as good, they are also understood to be moving toward the accomplishment of a good, flourishing or excellent life; that is, they are living well. While the cultivation of virtue does not aim at securing the agent's own flourishing independently of the flourishing of others (it is not egoistic in this sense), the successful cultivation of a virtuous character is conceptually inseparable from the possibility of a good life for the agent. Yet the way this good is achieved in action cannot be fixed by a set of advance rules or principles, but must be continually discerned by the agent herself in a manner that is adapted to the particular practical contexts and roles she occupies. This contextual element sets virtue ethics clearly apart from utilitarian and deontological frameworks, and it explains why virtue ethics is so useful for application to the military profession.

Virtue ethics presupposes that the appropriate actions of a courageous soldier in battle, for example, will be very different from those of a courageous teacher or courageous politician, and from how the soldier displays courage at home in civilian life. The virtuous agent is "prudentially wise," meaning that she is able to readily see what moral responses different situations call for, and she can adapt her conduct accordingly in a way that nevertheless reflects her unified character as a virtuous individual. What, then, are the implications of military enhancements for the ability of warfighters to cultivate and express virtue?

What follows does not exhaust the topics of potential concern about military enhancement and virtue, but merely an overview of the issues that are likely to matter most from a virtue-ethical standpoint:

What Counts as a "Virtuous" Enhancement?

Many proposed enhancements might be viewed as ways to directly enhance military virtue itself.

For example, if a pill, subdermal implant, or genetic alteration can make warfighters more willing to expose themselves to risk of harm, doesn't the enhancement make them more courageous? Yet this is too simple an analysis. From the moral standpoint, a trait or disposition is not a virtue just because it happens to result in appropriate actions. Virtuous actions must also emanate from the person's own moral viewpoint, that is, from his or her way of seeing and judging the ethical and practical implications of a situation. Otherwise the actions, however desirable from an institutional point of view, are not creditable to the moral character and wisdom of the agent. Thus if virtue and character matter in military ethics (note this assumes that we have gone beyond narrowly utilitarian considerations, such as risk-benefit calculations), then it very much matters how an enhancement modifies warfighters, not just how it affects their behavior.

For example, a pill that suppresses common physiologically-rooted panic reactions in battle looks compatible with virtue, if those reactions would otherwise undermine the soldier's training, expertise and rational grasp of the situation. Consider a soldier who successfully cultivates the thoughts, desires and feelings that are fitting for an excellent soldier in battle, but whose actions in the field are still hampered by autonomic symptoms of alarm beyond his or her control (e.g., shortness of breath, dangerously elevated pulse). Such a person could be aided in courage by an enhancement that short-circuits those symptoms.

Yet if the enhancement leads a soldier to act in ways that contradict a cognitive grasp of what's appropriate (e.g., "I knew it was too risky to engage that truck convoy without better reconnaissance, but for some reason I just did it anyway"), then the enhancement is actually an impediment to courage, in this case promoting the contrary vice of rashness. Alternatively, if the enhancement elicits apparently courageous actions from a soldier who continues to have seriously inappropriate feelings, attitudes, and judgments about battlefield risk, we would not say that the outcome of the enhancement is a courageous or "good" soldier; we have merely boosted the utility of a bad one. Enhancements of this sort would be problematic not only in particular cases, but also because they could interfere more generally with the ethical habituation of virtuous soldiers, who become prudentially wise actors only by habitually learning to see situations correctly and develop appropriate responses and strategies for dealing with them. If enhancements come to be used as a substitute for that learning process, they will actually hinder the cultivation of prudent, courageous and good soldiers, according to virtue ethics.

The issue of reversibility of enhancements is relevant here too. Since virtue presupposes the cognitive or affective flexibility to adapt behavior to circumstance and social context, an enhancement that "set" an agent's behavior patterns in a certain mode, or otherwise made his or her reaction patterns less adaptable (e.g., to civilian life or peacetime operations) would inhibit the ability to function virtuously and, by extension, to lead a good life. Even temporary enhancements could introduce this problem if they prevent the soldier from adapting well to the emerging exigencies of battle. A virtuous soldier is one who can immediately "dial down" the targeted desire to kill the enemy when a crowd of children unpredictably enters the field of action.

Virtue ethics also requires us to consider the potential impact of enhancements on moral leadership in military life. Most virtue ethicists

acknowledge that fully virtuous agents who cultivate and display moral wisdom in all of their professional and personal roles are usually a significant minority in any population: it's not easy to be virtuous. Therefore, one of the most important social and professional functions of the virtuous person is to serve as a moral example to which others aspire and strive to emulate. In the context of military life, this function is largely imputed to the officer corps. Enlisted soldiers are certainly recognized for exemplary acts of courage and valor, but as in any profession, complete military virtue is thought to require not only fine actions but also much experience, as well as mature reflection upon the goals and ideals of the profession—something officer training can provide.

This invites a novel set of ethical questions about enhancements, some recurring throughout this report: Will they be given to officers, or just combat soldiers? Will they erect a moral divide between the military ranks? Who will have greater "moral authority" and status as ethical exemplars: enhanced or unenhanced military personnel? How will enhancement impact the process of military education? Would an unenhanced officer's lessons on cultivating courage or fortitude over a lifetime of service be relevant to a soldier artificially enhanced for these qualities? There are also important questions about how enhancement might affect perceptions of military character by civilians and by unenhanced forces abroad; for example, will enhanced soldiers encounter less goodwill or greater resistance from those who see their status as antithetical to traditional ideals of military virtue and character?

Finally, ethical concerns with military enhancement do not end with the question of what it means to be a good soldier; they extend to what it means to be a good human being. There is a debate among virtue ethicists about whether virtue is rooted in a distinctive conception of what, if anything, a human should naturally be. Aristotle certainly thought so, but some modern virtue ethicists deny this [Swanton 2003; Slote 2011]. Still, most virtue ethicists believe that what is ethical for a human is inseparable from what is appropriate to human development on the whole. If they are right, then enhancements that take us too far from what is distinctively human are morally problematic in their own right. That said, enhancements that introduce non-natural physiology like the ability to eat grass or forgo sleep would be of far less concern to a virtue ethicist than enhancements that warp the distinctive moral, emotional and intellectual capacities that underpin virtue of character. For example, a pill or neural implant that disrupted or diminished a soldier's overall capacity to experience grief, guilt, compassion, curiosity, creativity, critical reflection or love would be highly problematic from a virtue-ethical standpoint [Nussbaum 2011].

7.2 Emotions and Honor[9]

Related to the issue of military virtues and professionalism is the question of what role emotions and honor, or codes of ethics, play in warfighters. With human enhancements, military organizations may elevate or diminish emotions and other psychological dispositions in their operators for some immediate benefit, but we also need to consider broader effects.

[9] We thank Prof. Shannon E. French for her discussion in this section, which includes material from *The Code of the Warrior* [French 2003].

So questions in this area include: Does participation in any war, regardless of whether one's own side of the conflict's participation fulfills just-war theory criteria, damages one's humanity? What does killing do to the psychological, spiritual, and emotional health of the warrior? What effect would human enhancements have with respect to that health?

Some scholars and clinicians assert that any violence against another human being causes the perpetrator psychological damage, even if the actions were taken undeniably in self-defense. Rachel MacNair, clinical psychologist and author of *Perpetration-Induced Traumatic Stress: The Psychological Consequences of Killing*, describes the dangers of taking another human life:

> All of these things—anxiety, panic, depression, substance abuse—can also be included in the "psychological consequences" of killing, along with such things as increased paranoia or a sense of disintegration, or dissociation or amnesia at the time of the trauma itself. […] In the case of killing, feelings of guilt can vary widely, from killing that is not socially approved, such as criminal homicide, to killing that is not only approved but expected, such as soldiers in war. People can feel guilty even under circumstances that involve clear self-defense…. [S]evere PTSD can be suffered without any feelings of guilt at all, and guilt can be suffered without any symptoms of PTSD [MacNair 2002, 7-8].

The warfighters' code of honor plays a key role in preserving their mental health, in addition to preventing atrocities. As French explains in *The Code of the Warrior* [French 2003]:

Murder is a good example of an act that is cross-culturally condemned. Whatever their other points of discord, the major religions of the world agree in the determination that murder (variously defined) is wrong. Unfortunately, the fact that we abhor murder produces a disturbing tension for those who are asked to fight wars for their tribes, clans, communities, cultures or nations. When they are trained for war, warriors are given a mandate by their society to take lives. But they must learn to take only certain lives in certain ways, at certain times, and for certain reasons. Otherwise, they become indistinguishable from murderers and will find themselves condemned by the very societies they were created to serve.

Warrior cultures throughout history and from diverse regions around the globe have constructed codes of behavior, based on that culture's image of the ideal warrior. These codes have not always been written down or literally codified into a set of explicit rules. A code can be hidden in the lines of epic poems or implied by the descriptions of mythic heroes. One way or another, it is carefully conveyed to each succeeding generation of warriors. These codes tend to be quite demanding. They are often closely linked to a culture's religious beliefs and can be connected to elaborate (and frequently death defying or excruciatingly painful) rituals and rites of passage.

In many cases this code of honor seems to hold the warrior to a higher ethical standard than that required for an ordinary citizen within the general population of the society the warrior serves. The code is not imposed from the outside. The warriors themselves police strict adherence to these standards; with violators being shamed, ostracized, or even killed by their peers.

The code of the warrior not only defines how he should interact with his own warrior comrades,

but also how he should treat other members of his society, his enemies, and the people he conquers. The code restrains the warrior. It sets boundaries on his behavior. It distinguishes honorable acts from shameful acts.

But why do warriors need a code that ties their hands and limits their options? Why should a warrior culture want to restrict the actions of its members and require them to commit to lofty ideals? Might not such restraints cripple their effectiveness as warriors? What's wrong with, "All's fair in love and war?" Isn't winning all that matters? Are concerns about honor and shame burdens to the warrior? And, again, what is the interplay between cognitive enhancements and this code of honor?

One reason for such warriors' codes may be to protect the warrior himself (or herself) from serious psychological damage. To say the least, the things that warriors are asked to do to guarantee their cultures' survival are far from pleasant. Even those few who, for whatever reason, seem to feel no revulsion at spilling another human being's guts on the ground, severing a limb, slicing off a head, or burning away a face are likely to be affected by the sight of their friends or kinsmen suffering the same fate. The combination of the warriors' own natural disgust at what they must witness in battle and the fact that what they must do to endure and conquer can seem so uncivilized, so against what they have been taught by their society, creates the conditions for even the most accomplished warriors to feel tremendous self-loathing.

In the introduction to his valuable analysis of Vietnam veterans suffering from post-traumatic stress disorder (PTSD), *Achilles in Vietnam: Combat Trauma and the Undoing of Character*, psychiatrist and author Jonathan Shay stresses the importance of "understanding…the specific nature of catastrophic war experiences that not only cause lifelong disabling psychiatric symptoms but can *ruin* good character" [Shay 1994, xiii]. Shay has conducted countless personal interviews and therapy sessions with American combat veterans who are part of the Veterans Improvement Program (VIP). His work has led him to the conclusion that the most severe cases of PTSD are the result of wartime experiences that are not simply violent, but which involve what Shay terms the "betrayal of 'what's right'" [Shay 1994]. Veterans who believe that they were directly or indirectly party to immoral or dishonorable behavior (perpetrated by themselves, their comrades, or their commanders) have the hardest time reclaiming their lives after the war is over. Such men may be tortured by persistent nightmares, may have trouble discerning a safe environment from a threatening one, may not be able to trust their friends, neighbors, family members, or government, and many have problems with alcohol, drugs, child or spousal abuse, depression, and suicidal tendencies. As Shay sorrowfully concludes, "The painful paradox is that fighting for one's country can render one unfit to be its citizen" [Shay 1994, xx].

Warriors need a way to distinguish what they must do out of a sense of duty from what a serial killer does for the sheer sadistic pleasure of it. Their actions, like those of the serial killer, set them apart from the rest of society. Warriors, however, are not sociopaths. They respect the values of the society in which they were raised and which they are prepared to die to protect. Therefore, it is important for them to conduct themselves in such a way that they will be honored and esteemed by their communities, not reviled and rejected by them. They want to be seen as proud defenders and representatives of

what is best about their culture: as heroes, not "baby-killers."

In a sense, the nature of the warrior's profession puts him or her at a higher risk for moral corruption than most other occupations because it involves exerting power in matters of life and death. Warriors exercise the power to take or save lives, order others to take or save lives, and lead or send others to their deaths. If they take this awesome responsibility too lightly—if they lose sight of the moral significance of their actions—they risk losing their humanity and their ability to flourish in human society.

In his powerful work, *On Killing: The Psychological Cost of Learning to Kill in War and Society*, Lt. Col. Dave Grossman illuminates the process by which those in war and those training for war attempt to achieve emotional distance from their enemies. The practice of dehumanizing the enemy through the use of abusive or euphemistic language is a common and effective tool for increasing aggression and breaking down inhibitions against killing:

> It is so much easier to kill someone if they look distinctly different than you. If your propaganda machine can convince your soldiers that their opponents are not really human but are "inferior forms of life," then their natural resistance to killing their own species will be reduced. Often the enemy's humanity is denied by referring to him as a "gook," "Kraut," or "Nip" [Grossman 1996, 161].

Like Shay, Grossman has interviewed many US veterans of the Vietnam War. Not all of his subjects, however, were those with lingering psychological trauma. Grossman found that some of the men he interviewed had never truly achieved emotional distance from their former foes, and seemed to be the better for it. These men expressed admiration for Vietnamese culture. Some had even married Vietnamese women. They appeared to be leading happy and productive post-war lives. In contrast, those who persisted in viewing the Vietnamese as "less than animals" were unable to leave the war behind them.

Grossman writes about the dangers of dehumanizing the enemy in terms of potential damage to the war effort, long-term political fallout, and regional or global instability:

> Because of [our] ability to accept other cultures, Americans probably committed fewer atrocities than most other nations would have under the circumstances associated with guerrilla warfare in Vietnam. Certainly fewer than was the track record of most colonial powers. Yet still we had our My Lai, and our efforts in that war were profoundly, perhaps fatally, undermined by that single incident.
>
> It can be easy to unleash this genie of racial and ethnic hatred in order to facilitate killing in time of war. It can be more difficult to keep the cork in the bottle and completely restrain it. Once it is out, and the war is over, the genie is not easily put back in the bottle. Such hatred lingers over the decades, even centuries, as can be seen today in Lebanon and what was once Yugoslavia [Grossman 1996, 163].

The insidious harm brought to the individual warriors who find themselves swept up by such devastating propaganda matters a great deal to those concerned with the warriors' own welfare. In a segment on the "Clinical Importance of

Honoring or Dishonoring the Enemy," Jonathan Shay describes an intimate connection between the psychological health of the veteran and the respect he feels for those he fought. He stresses how important it is to the warrior to have the conviction that he participated in an *honorable* endeavor:

> Restoring honor to the enemy is an essential step in recovery from combat PTSD. While other things are obviously needed as well, the veteran's self-respect never fully recovers so long as he is unable to see the enemy as worthy. In the words of one of our patients, a war against subhuman vermin "has no honor." This is true even in victory; in defeat, the dishonoring absence of human *themis* [shared values, a common sense of "what's right"] linking enemy to enemy makes life unendurable [Shay 1994, 115].

Shay finds echoes of these sentiments in the words of J. Glenn Gray from Gray's modern classic on the experience of war, *The Warriors: Reflections on Men in Battle*. With the struggle of the Allies against the Japanese in the Pacific Theater of World War II as his backdrop, Gray brings home the agony of the warrior who has become incapable of honoring his enemies and thus is unable to find redemption himself:

> The ugliness of a war against an enemy conceived to be subhuman can hardly be exaggerated. There is an unredeemed quality to battle experienced under these conditions, which blunts all senses and perceptions. Traditional appeals of war are corroded by the demands of a war of extermination, where conventional rules no longer apply. For all its inhumanity, war is a profoundly human institution….This image of the enemy as beast lessens even the satisfaction in destruction, for there is no proper regard for the worth of the object destroyed….The joys of comradeship, keenness of perception, and sensual delights [are] lessened…. No aesthetic reconciliation with one's fate as a warrior [is] likely because no moral purgation [is] possible [Gray 1998, 152-153].

By setting standards of behavior for themselves, accepting certain restraints, and even "honoring their enemies," warriors can create a lifeline that will allow them to pull themselves out of the hell of war and reintegrate themselves into their society, should they survive to see peace restored. A warrior's code may cover everything from the treatment of prisoners of war to oath keeping to table etiquette, but its primary purpose is to grant nobility to the warriors' profession. This allows warriors to retain both their self-respect and the respect of those they guard [French 2003].

Cognitive enhancements, then, would operate against this complex and subtle background to effects that may be psychologically disastrous or difficult to predict.

7.3 Broader Impacts

From the preceding, we can see that concerns about military enhancements can be focused inward, toward the health and character of the human subject. But these concerns can also ripple outward, focused beyond the human subject. These issues engage law, policy, and ethics, as we have discussed in section 3; for instance, how do enhancements impact military operations, including how adversaries might respond? But since enhancements change the human person—the basic unit of society—we can expect changes and challenges beyond such

first-order and second-order effects. These broader impacts are temporally more distant and therefore tend to be discounted; but they are nevertheless foreseeable and should also be considered ahead of rapidly advancing science and technology.

First, we can expect the proliferation of perhaps every military technology we invent, as history shows. For instance, besides WWII-era Jeeps and modern-day Humvees returned to society as better-polished civilian models; and GPS was directly adopted by society without any modification [Lin 2010]. The method of diffusion would be different and more direct with enhancements, though: Most warfighters return to society as civilians (our veterans) and would carry back any permanent enhancements and addictions with them. Again, the US has about 23 million veterans, or one out of every 10 adults, in addition to 3 million active and reserve personnel [US Census 2011], so this is a significant segment of the population. Would these enhancements—such as a drug or an operation that subdues emotions—create problems for the veteran to assimilate to civilian life? What kinds of pressures and how much, including healthcare costs, would be placed on the Department of Veteran Affairs, given military enhancements; and are we prepared to handle those costs?

Proliferation into society is not limited to our own borders, but we can expect it to occur internationally, again as history shows. Even the military robotics that have been deployed in war only within the last decade is not just a US phenomenon, as much as it may seem from the international media's focus. It is reported that more than 50 nations now have or are developing military robotics, including China and Iran [Singer 2009b; Sharkey 2011]. Where the US deploys robots for their considerable advantages in surveillance, strike, and other roles, we would be unprepared to receive the same treatment if (and when) it is inflicted upon us. With nuclear weapons, while the US had the first-mover advantage, proliferation pushed us toward non-use agreements and erased much of that advantage [International Atomic Energy Agency 1970]. Likewise with military enhancements (and robotics), we can expect other nations to develop or adopt the same technologies we develop and therefore, at some point, have the same capabilities, again diminishing the competitive benefits once derived from the enhancements.

The wider impact of military enhancements echoes those already identified in the rich literature on human enhancements generally, for instance: Would enhanced veterans—say, with bionic limbs and augmented cognition—put other civilians at a competitive disadvantage with respect to jobs, school, sports, and so on? Would this create an enhancement arms-race beyond steroids, as is now starting in sports? If enhanced veterans (and the other enhanced people they inspire) live longer than usual, does that put undue burdens on social security and pension funds? Would these advantages create social pressures to enhance more generally, as we are witnessing with modafinil—a cognitive enhancer—in both the classroom and the workplace?

Relatedly, would enhanced warfighters be bad role models, such as steroid-using athletes, for children? We can expect some children will want to enhance themselves, and some will succeed. But this seems bad insofar as their bodies are still developing and anyway don't have full intellectual or legal capacity to make informed life-altering decisions (e.g., tattoos). Enhancements, as distinct from purely therapeutic uses, would

likely not have been tested on normal children and other populations, such as pregnant women and those of advanced age, in that it may be too risky to conduct such testing on those healthy individuals, relative to the benefits. That is, there would be no countervailing benefit of helping to cure the individual of an illness, if those subjects were normal to begin with.

Earlier, we discussed the issue of access to enhancements within the military: Who should receive them, some warfighters or all; and what problems could unequal access create? At a larger societal scale, there may be friction between the enhanced and unenhanced, or at least a class divide—in terms of education, job outlook, etc.—as we already see between those with Internet access and those without. If enhancements in society are expensive and only afforded by the more wealthy, then this may widen the gap between the haves and the have-nots. Similarly, would there be a communication divide between the enhanced and unenhanced, if the former can see in different wavelengths and have different powers of perception? On the other hand, if there's no moral issue generally with enhancing humans, then why not uplift animals closer to human-level intelligence [Dvorsky 2012], building on chimera work previously discussed?

While neither international nor domestic law requires that we consider these and other societal effects, ethics and public policy do. Without proper management, technological disruptions can have serious, avoidable effects. Possible solutions, as suggested for other issues previously considered, may include a policy to implement only reversible or temporary enhancements in the military as a firewall for broader society. To be sure, some commentators do not view enhancements in the general population as a bad or unmanageable outcome. So this continuing wider debate on human enhancements—which we will not explicate here, as it is available elsewhere [Allhoff et al. 2010a]—should be of interest to the military, especially as the military is a key driver of new technologies that eventually make their way into broader society.

7.4 Conclusion

Human enhancements have the potential to make it easier and safer for warfighters to do their job. Enhancements have a long history in the military, but recent opposition to their use in realms such as sports and academia, as well as controversy over the off-label or experimental use of certain drugs by the military, are forcing questions about the appropriateness of their use by the military. While military enhancements have largely escaped the scrutiny of the public as well as policymakers, the science and technologies underwriting human enhancements are marching ahead.

The military technology getting the most attention now is robotics. As we suggested throughout the report, there may be ethical, legal, and policy parallels between robotics and enhancements, and certainly more lessons can be drawn. We can think of military robotics as sharing the same goal as human enhancement. Robotics aims to create a super-soldier from an *engineering* approach: they are our proxy mecha-warriors. However, there are some important limitations to those machines. For one thing, they don't have a sense of ethics—of what is right and wrong—which can be essential on the battlefield and to the laws of war. Where it is child's play to identify a ball or coffee mug or a gun, it's notoriously tough for a computer to do that, especially objects that are novel or

otherwise unlabeled [Le et al. 2012]. This does not give us much confidence that a robot can reliably distinguish friend from foe, at least in the foreseeable future.

In contrast, cognitive and physical enhancements aim to create a super-soldier from a *biomedical* direction, such as with drugs and bionics. For battle, we want our soft organic bodies to perform more like machines. Somewhere in between robotics and biomedical research, we might arrive at the perfect future warfighter: one that is part machine and part human, striking a formidable balance between technology and our frailties. Indeed, the field of neuromorphic robots already aims to fill this gap by using biological brains to control robotic bodies [Krichmar and Wagatsuma 2011].

In changing human biology with enhancements, we also may be changing the assumptions behind existing laws of war and even human ethics. If so, we would need to reexamine the foundations of our social and political institutions—including the military—if prevailing norms create "policy vacuums" [Moor 2005] in failing to account for new technologies [Lin 2012b; Lin, Allhoff, and Rowe 2012; Taddeo 2012].

In comic books and science fiction, we can suspend disbelief about the details associated with fantastical technologies and abilities, as represented by human enhancements. But in the real world—as life imitates art, and "mutant powers" really are changing the world—the details matter and will require real investigations.

Two key overarching, and particularly difficult, themes in the report are (1) military necessity and (2) autonomy of soldiers. As we have explained, these concepts need to be further explored in the context of military enhancements. Military necessity is arguably the prime consideration for military decision-making generally [O'Meara 2012a, 2012b]. Yet it is often unclear what counts as "necessary." On a sliding scale, as certainty of necessity decreases, it seems that consent of the military human subject becomes more relevant. Yet it, too, is unclear whether warfighters are in a position to give truly voluntary and informed consent, given such factors as their youth, military training regimen to subordinate individuality over the greater good, and a strong tendency to follow orders, both direct and implied.

The issues discussed in this report are complex, given an unfamiliar interplay among technology ethics, bioethics, military law, and other relevant areas. As such, further studies will require close collaborations with a range of disciplines and stakeholders, as is increasingly the case in technology ethics [Brey 2000]. Given the pervasive role of national security and defense in the modern world in particular, as well as the flow of military technologies into civilian society, many of these issues are urgent now and need to be actively engaged, ideally in advance of or in parallel with rapidly emerging science and technologies.

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Appendix 1: List of Acronyms

AVIP	Anthrax Vaccine Immunization Program
BT	Botulinum toxin
BTWC	Biological and Toxin Weapons Convention
DARPA	Defense Advanced Research Projects Agency
DoD	Department of Defense
DoDD	Department of Defense Directive
FDA	Food and Drug Administration
IHL	International humanitarian law
IND	Investigational drug
IRB	Institutional review board
JWT	Just-war theory
LOAC	Laws of armed conflict
NBC	Nuclear, Biological, Chemical
NCO	Non-commissioned officers
NIH	National Institute of Health
PB	Pyridostigmine bromide
PMC	Private military contractors
PRT	Physical readiness training
PTSD	Post traumatic stress disorder
RAC	Recombinant DNA Advisory Committee
RBA	Risk-benefit analysis
SIrUS	Superfluous injury or unnecessary suffering
UAV	Unmanned aerial vehicles
UCMJ	Uniform Code of Military Justice
VA	Veteran Affairs
WMA	World Medical Association

Appendix 2: Authors

Dr. Patrick Lin is the director of the Ethics + Emerging Sciences Group at California Polytechnic State University, San Luis Obispo, where he is an associate philosophy professor. He is also an affiliate scholar at Stanford Law School's Center for Internet and Society; an adjunct senior research fellow at Australia's Centre for Applied Philosophy and Public Ethics; and the research director for the Consortium on Emerging Technologies, Military Operations, and National Security (CETMONS). Previously, Dr. Lin was an ethics fellow at the US Naval Academy and a post-doctoral associate at Dartmouth College. He is well published in the technology ethics, including co-editing or co-authoring four books, most recently *Robot Ethics* (MIT Press) and *What Is Nanotechnology and Why Does It Matter?* (Wiley-Blackwell). He was also the lead author of an ethics and policy report on autonomous military robots (Office of Naval Research-funded) and another on human enhancement technologies (National Science Foundation-funded). On military technologies, Dr. Lin has delivered invited talks and briefings to policy, defense, intelligence, and scientific organizations internationally. He earned his BA from UC Berkeley and PhD from UC Santa Barbara.

Prof. Maxwell J. Mehlman is the Arthur E. Petersilge Professor of Law and Director of the Law-Medicine Center, Case School of Law, and Professor of Biomedical Ethics, Case School of Medicine. He received his JD from Yale Law School in 1975, and holds two bachelor's degrees, one from Reed College and one from Oxford University, which he attended as a Rhodes Scholar. Prior to joining the Case faculty in 1984, Professor Mehlman practiced law with Arnold & Porter in Washington, DC, where he specialized in federal regulation of health care and medical technology. He is the co-author of *Access to the Genome: The Challenge to Equality*; co-editor, with Tom Murray, of the *Encyclopedia of Ethical, Legal and Policy Issues in Biotechnology*; co-author of *Genetics: Ethics, Law and Policy,* the first casebook on genetics and law, now in its third edition; author of *Wondergenes: Genetic Enhancement and the Future of Society*, published in 2003 by the Indiana University Press; author of *The Price of Perfection: Individualism and Society in the Era of Biomedical Enhancement*, published in 2009 by the Johns Hopkins University Press, and most recently, the author of *Transhumanist Dreams and Dystopian Nightmares: The Promise and Peril of Genetic Engineering*, published by the Johns Hopkins University Press in 2012. He is a member of the Consortium on Emerging Technologies, Military Operations, and National Security (CETMONS), head of its Bioenhanced Warfighter Thrust Group. Professor Mehlman is the principal investigator on an NIH-funded project to examine ethical, legal, and policy issues raised by the use of genomic science by the military.

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