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BUILDING A BETTER SOLDIER: HUMAN ENHANCEMENT TECHNOLOGIES IN THE 21ST CENTURY

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Introduction

On April 2nd, 2013, *The New York Times* reported that President Obama announced an ambitious, new research initiative, “to invent and refine new technologies to understand the human brain...”¹ According to the article’s author, John Markoff, the project has been compared to the Human Genome Project because of its aim to map and record brain circuits; nevertheless, there is one large difference: Neither President Obama, nor any of his administration have officially declared an endpoint or goal for the brain-mapping initiative.² The President *did* announce that his budget for 2014 would include \$100 million for the project, which is being called BRAIN: Brain Research through Advancing Innovative Neurotechnologies.³ Regarding the Initiative, the President said

¹ Markoff, John. “Obama to Unveil Initiative to Map the Human Brain.” *New York Times*, sec. Science, April 02, 2013.

² *Ibid*

³ Pathe, Simone. “Obama Hopes Mapping Project Reveals Brain’s Mysteries.” *PBS NewsHour Extra*, April 08, 2013.

funding would give “scientists the tools they need to get a dynamic picture of the brain in action and better understand how we think and how we learn and how we remember.”⁴ One of the three government agencies slated to receive funds from the BRAIN Initiative is the Defense Advanced Research Projects Agency (DARPA), which will receive \$50 million.⁵

This isn’t the first time in recent history that DARPA has received a large sum of money to finance neuroscience research. In 2011, DARPA received approximately \$240 million to fund its brain research, much of which has dual-use purposes that benefit American civilians as well as military forces.⁶ Furthermore, the BRAIN Initiative seems to fall in line with the projects President Obama brought up in his State of the Union address in January.⁷ Mark Memmott of NPR offers some insight into the importance of this Initiative in the eyes of the Obama administration. According to Memmott, during his White House announcement about the BRAIN Initiative, President Obama said successful government research has “changed our lives in ways we could never imagine,” specifically mentioning the development of computer chips, GPS, the Internet, and “other technologies.”⁸ Furthermore, the U.S. Department of Health & Human Services claims that “by accelerating the development and application of innovative technologies, researchers will be able to produce a revolutionary new dynamic picture of the brain that, for the first time, shows how individual cells and complex neural circuits interact in both time and space.”⁹ Additionally, they hope the research this Initiative produces will “fill major gaps in our current knowledge and provide unprecedented opportunities for exploring exactly how the brain enables the human body to record, process, utilize, store, and retrieve vast quantities of information, all at the speed of thought.”¹⁰ Understanding

⁴ Ibid

⁵ Wilson, Scott. “Obama outlines human brain-mapping initiative.” *The Washington Post*, April 02, 2013.

⁶ Moisse, Katie. “The Dark Side of Military-Funded Neuroscience.” *ABC News*, sec. Health, March 21, 2012.

⁷ Memmott, Mark. “Obama Says \$100 Million Will Be Invested In Brain-Mapping Initiative.” *NPR*, April 02, 2013.

⁸ Memmott, “Obama Says \$100 Million Will Be Invested In Brain-Mapping Initiative.”

⁹ U.S. Department of Health & Human Services, National Institute of Health, “Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative.” (Accessed May 19, 2013).

¹⁰ Ibid

how the brain works could be the key to creating new, innovative technologies that benefit public and private sectors.

Yet, with a bit of reading between the lines, the potential application of these research findings doesn't seem to be purely medical or scientific. A closer look at the allocation of BRAIN Initiative funds hints at perhaps an ulterior, or at least additional, motive for the Obama administration. As Patrick Lin of *The Atlantic* notes: "...defense-related applications are a major driver of science and technology research."¹¹ With DARPA receiving nearly half of the U.S. government's funding from the BRAIN Initiative, the dual-use intent becomes clearer. A quick glance at the White House webpage for the Initiative outlines DARPA's role: "\$50 million for understanding the dynamic functions of the brain and *demonstrating breakthrough applications* based on these insights."¹² DARPA is an agency of the United States Department of Defense whose primary task is developing new technologies for use by the military. Thus, it can be concluded that the BRAIN Initiative serves at least *some* military purpose. Moreover, fifty million dollars is half of the federal funding for this Initiative, meaning that DARPA is receiving the most federal funding out of the three agencies slated to receive funds. If we imagine that allocation of funds is representative of the relative importance of each agency, then it becomes obvious that defense is the U.S. government's primary goal. A better understanding of the brain and a more comprehensive map, two of the Initiative's goals, will bolster DARPA's research capabilities in neuroscience and accelerate its ability to use these advances for enhancing humans in combat. While much of the research outcomes that are highlighted by the U.S. government relate to curing diseases, an inescapable question arises as to what this kind of research means for the future of warfare. If the United States begins to build an army of super humans, what will be the implications for world politics? As we have seen with the recent history of nuclear weapons, development of new military technologies can lead to security dilemmas, arms races, and a slew of reactionary plays from states that fear for the future of their international power and security. Cognitive/neural enhancement of human beings is just one area of research that DARPA is already pursuing

¹¹ Lin, Patrick. "Could Human Enhancement Turn Soldiers Into Weapons That Violate International Law? Yes." *The Atlantic*, sec. Tech, January 04, 2013.

¹² Barack, Obama. "BRAIN Initiative," *The White House*. (Accessed May 19, 2013).

in the area of human enhancement technology (HET), along with biological enhancement and enhanced materials.¹³ Thus, the proposed BRAIN Initiative and its military implications lead us to the following question: How will human enhancement technologies (HET) alter warfare in the 21st century?

Conventional Wisdom

Typically, Americans seem to be enthusiastic about human enhancement research because of its medical and therapeutic applications. According to the *Pew Research Center*, non-partisan polling data suggests that most people are optimistic about the medical advances that will likely result from human enhancement research.¹⁴ The National Science Foundation reported similar results in their polling data. For instance, according to a 2002 Life Sciences Survey, 86% of American respondents agreed that “developments in science have helped make society better,” and 90% agreed “scientific research is essential for improving the quality of human lives.”¹⁵ Furthermore, the NSF data found that 72% of Americans believed “the benefits of scientific research outweigh any harmful results.”¹⁶

Americans are technological optimists, especially in regard to science and medicine. They believe that technology has consistently improved their lives for the better and that it will continue to do so in the future. Americans seem to have faith in the ability of science to overcome many of the problems plaguing the world, such as disease and illness. However, according to *Pew*, Americans seem to be aware of the implications of enhancement technologies. Another non-partisan poll found that many people correctly believe there are some serious risks for society involved with pursuing human enhancement research.¹⁷ Nevertheless, Americans’ technological optimism prevails in the polling data, highlighting their belief that the benefits of biotechnology outweigh those risks.

¹³ DARPA, “Defense Sciences Office.” (Accessed May 19, 2013).

¹⁴ Pew Research Center, “Are you very optimistic about the possibility of medical advances as a result of genetic research, somewhat optimistic, not too optimistic, or not at all optimistic?.” Last modified July 2000. (Accessed May 19, 2013).

¹⁵ National Science Foundation, “Science and Engineering Indicators 2004.” (Accessed May 19, 2013).

¹⁶ *Ibid*

¹⁷ Pew Research Center, “As you may know, scientists have recently discovered how to map the human genetic code. In your opinion, will this mostly be a good thing for our society, or are there some serious risks involved?.” Last modified July 2000. (Accessed May 19, 2013).

This paper argues this conventional wisdom is incomplete. While it is true that HET may break through some medical barriers and lead to cures for serious ailments, it is also true that these medical advances have an increasingly complex relationship with military technology. Many historical medical advances that have benefited civilians have been born of a need to aid soldiers in or after combat.¹⁸ It is unrealistic for Americans to believe that HET can or will only mean advances for therapeutic and/or civilian medical purposes in the future. Technology doesn't dictate how it's used. According to experts,¹⁹ the future of biotechnology seems to be aimed at using biology to "enhance our capabilities to conduct military operations: not by degrading our adversaries, but by improving the material of war, enhancing the performance of warriors, and using biological processes to improve systems design and performance."²⁰ This is a new kind of biotechnology. While in the past the term biotechnology conjured up images of offensive germ attacks, in the future the term could be used to describe biologically enhanced soldiers. Americans are right to believe that there are serious risks involved in pursuing HET. However, in this instance, America's technological optimism is leading it to have more faith than perhaps it should. Americans do not seem to fully understand just how entangled medicine and defense research really are or how much more complicated that entanglement is likely to get in the future. Certainly, as we can already see, human enhancement technology likely means human enhancement in both medical and military settings.

Qualitative Methodology

This paper uses qualitative methodology to first examine the theoretical paradigm, realism, and second, to examine three case studies that help reveal the role human enhancement technology will play in 21st century warfare. As case studies, this paper examines three categories of human enhancement technology with potential military applications: human biological enhancement, human cognitive/neural enhancement, and enhanced materials.

¹⁸ See: smallpox vaccine, yellow fever, antityphoid vaccine, syphilis blood test, rabies vaccine, etc.

¹⁹ Robert E. Armstrong is a senior research fellow in the Center for Technology and National Security Policy at the National Defense University. Jerry B. Warner is president of Defense Life Sciences.

²⁰ Armstrong & Warner, "Biology and the Battlefield," pp. 2.

For these three case studies, this paper will use a combination of both primary and secondary sources as evidence to determine how human enhancement technology will alter warfare in the 21st century. The primary evidence draws from U.S. government advisory reports, such as those from JASON, non-partisan statistical data, DARPA reports, and archival evidence. JASON and DARPA reports give insight into the kind of research that is already being conducted and its potential military applications. This paper will also use evidence provided by secondary sources such as the *New York Times*, *The Atlantic*, and the *Washington Post*, as well as scholarly journals. Robert Armstrong and Jerry Warner's article, "Biology and the Battlefield", published in the March 2003 edition of *Defense Horizons* provides expert insight into the history and future of biological research for military purposes. Furthermore, Fred Ikle's book, *Annihilation from Within: Ultimate Threat to Nations*, is an important resource that provides a detailed examination of how HET will affect the future of political order. Empirical evidence from sources such as these provides a better platform for understanding the effect human enhancement technology will have on warfare and the further effects it will have on the international balance of power.

Theoretical Paradigm

The answer to this research question is best framed using the realist theory of international relations. Realism is made up of several basic assumptions. One assumption is that the international system is anarchic. Realists would argue: "There is no essential harmony of interests between states, but rather a web of conflicting national objectives in an anarchical world."²¹ The second assumption posits that states are the highest centralized authority, making them the most important actors on the international stage. The third assumption is that states' decision-making is rational and therefore based on their own best interests instead of in the interest of international cooperation. In short, this assumption of the realist theory can be summed up as "might is right."²² If a state is rational and acting in its own best interest, then realism assumes that survival is a state's primary concern. Essentially, "power or state capabilities,

²¹ Sean Murphy, *Principles of International Law*, (St. Paul: West, 2006): 18.

²² Moseley, Alexander, ed. *Internet Encyclopedia of Philosophy*. 2001. s.v. "Political Realism."

rather than common interests, shape relations among nations...²³ For realists, cooperation only exists if interests coincide, but certainly isn't born of shared moral or ethical principles.²⁴ However, it is important to note that this isn't the radical or extreme realism expressed by the Machiavellian doctrine "that anything is justified by reason of state."²⁵ The line should be drawn between such extreme realism and the assumptions of classical realism described above when framing this research question. While classical realism emphasizes that a state will act in its own best interest, it does not involve the "glorification of war or conflict."²⁶

In examining the impact that human enhancement technology will have on military operations, it is clear that the realist theory can be applied. The realist emphasis on competition, states' concern for their own security and interests, and struggle for power are represented in the U.S. government's investment in human enhancement technology. Realists consider anarchy to be what determines the outcomes in international politics. The international stage is literally a self-help system because it lacks a common governing authority. Under the realist theory, the United States is responsible for its own survival and is "free to define its own interests and to pursue power."²⁷ In this case, the United States is pursuing power in the form of human enhancement technology because it believes HET will maximize its power and will give it a leg up on military power relative to other states. The U.S. seeks to remain hegemonic and the best way to do that is to ensure that it always has an advantage by being at the forefront of new technology.

The U.S.'s development of human enhancement technologies can be directly explained by the realist notion of relative power. The first states to harness these new technologies will have an advantage and a new way in which to secure power relative to other states. The ability to engineer better soldiers will improve the efficiency of any military that can afford to harness the technology. According

²³ Sean Murphy, *Principles of International Law*, pp. 18.

²⁴ *Ibid*

²⁵ Hedley Bull, "The Theory of International Politics 1919–1969," *International Theory: Critical Investigations*, ed. J. Den Derian (London: Macmillan Publishing, 1995): 189.

²⁶ Korab-Karpowicz, W. Julian, ed. *Stanford Encyclopedia of Philosophy*. 2010. s.v. "Political Realism in International Relations."

²⁷ Korab-Karpowicz, "Political Realism in International Relations."

to the realist system, once they do that, they will become stronger international forces and secure their place on the international stage. Thus, actors such as the U.S. have an incentive to develop these technologies first to ensure their continued placement at the top.

The conventional wisdom cannot be framed or explained by the realist theory. The conventional wisdom is best framed using the constructivist theoretical paradigm of international relations. The key principle of constructivism is that international relations are shaped by constructed ideas such as “ideas, beliefs, norms/values, religion, culture, and/or nationalism.”²⁸ Thus, perceptions hold just as much if not more weight in international politics than the facts do. If we view the conventional wisdom through the constructivist lens, we can see that the layman applies this theory to the issue of human enhancement technology. Essentially, Americans believe that the future of human enhancement is socially constructed and not an inevitable reality.

Case Study: Biological/Physical Enhancement

Human enhancement can be described as: 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’.”²⁹ The military use of human enhancement technologies isn’t a new idea. Under some definitions of human enhancement, vaccines count as a type of enhancement of the immune system. This would place the first military use of human enhancement technologies during the American Revolutionary War from 1775-1783 when George Washington had the Continental Army vaccinated against smallpox.³⁰

The current focus of the U.S. military on human enhancement aligns with its logical objective to maximize the performance of its troops. According to an Army training manual:

“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

²⁸ Hurt, Shelley. “Introduction to International Relations: Theoretical Paradigms of International Relations.”

²⁹ Patrick Lin, Maxwell Mehlman, and Keith Abney, *Enhanced Warfighters: Risk, Ethics, and Policy*. (The Greenwall Foundation, 2013): 11.

³⁰ Armstrong & Warner, “Biology and the Battlefield,” pp. 2.

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.”³¹

DARPA already has several programs in place that are aimed at enhancing the U.S. military using biological means. DARPA calls these types of programs “Maintaining Human Combat Performance” programs. Each individual program has unique goals but they are all related because they are aimed at enhancing soldiers through biology. Enhancing the human immune system has been a longtime goal of scientists and the military alike. According to Mark Wheelis, “tools are rapidly becoming available that will produce improved vaccines (more efficient, longer lasting, and safe), produce new antibiotics and antivirals, enhance defenses against diseases, and protect against damage from overreaction of defensive systems.”³² One such program is DARPA’s 7-Day Biodefense program. The goal of the program is to “develop innovative approaches to counter pathogens without regard to their exact nature.”³³ Similarly, DARPA’s Prophecy program “seeks to transform the vaccine and drug development enterprise from observational and reactive to predictive and preemptive by spurring development of a multidisciplinary approach to predicting viral evolution.”³⁴ If a military can harness the human immune system, they will be considerably less vulnerable to biological warfare. This could tip the balance of power away from states intending to implement biological weapons and toward states that have militaries able to withstand these attacks. Furthermore, the U.S. military might be more likely to use biological weapons if they know there won’t be any collateral damage to their own soldiers.

³¹ Tanja Roy, Barbara Springer, Vancil McNulty, and Nikki Butler, “Physical Fitness,” *Military Medicine*, no. 175 (2010): 14-20.

³² Wheelis, Mark, “Will the New Biology Lead to New Weapons?” *Arms Control Today*. (July/August 2004): 3.

³³ DARPA. “7-Day Biodefense.” (Accessed May 26, 2013).

³⁴ DARPA, “Prophecy (Pathogen Defeat).” (Accessed May 26, 2013).

A more extreme form of biological human enhancement is human-machine interface. According to JASON, non-invasive “brain control” is unrealistic.³⁵ This only means that JASON doesn’t foresee a way of using this technology without a permanent medical procedure. However, successful implementations of invasive interfaces have occurred in “medical applications in which nerve signals are used as the mechanism for information transfer.”³⁶ This might mean that the more extreme example of potential remote guidance of a human being could be successful in the future, should the U.S. or another state decide to implement it. A more realistic possibility is the use of medical devices created to fix impairment in completely healthy soldiers.

What if the military began to give cochlear implants to its healthy soldiers in order to make their normal hearing extraordinary? Or if the military could alter human genes to make soldiers run faster and carry heavier loads? We now know enough about biology and engineering to make these enhancements a reality. According to a 2010 JASON advisory report: “both offensive and defensive military operation may be impacted by the appliance of personal genomics technologies through enhancement of the health, readiness, and performance of military personnel.”³⁷ In this 2010 report, JASON—the U.S. government’s most esteemed group of scientists—advised the United States that they would benefit significantly if they employed genomics technologies when assessing the health and performance capabilities of the military.³⁸ Later in the same report, JASON advises the Department of Defense to “determine which phenotypes that might reasonably be expected to have a genetic component [with] special relevance to military performance...”³⁹ Although it is unlikely that the U.S. will implement as invasive a procedure as genetic modification anytime in the near future, it is a scientific possibility that may be imposed upon U.S. soldiers at some point or be utilized by states without moral opposition to it. Moreno has pointed out: “According to the Uniform Code of Military Justice, soldiers are required to accept medical interventions that make them fit for duty. Experimental treatments are a harder case, but the US government has

³⁵ JASON. 2008. Human Performance, Report No. JSR-07-625, March 2008: 77.

³⁶ Ibid

³⁷ JASON. 2010. The \$100 Genome: Implications for the DoD, Report No. JSR-10-100, December 2010: 1.

³⁸ JASON. 2010. The \$100 Genome: Implications for the DoD, pp. 4.

³⁹ JASON. 2010. The \$100 Genome: Implications for the DoD, pp. 43.

shown a tendency to defer to commanders in a combat situation if they think some treatment is likely to do more harm than good, even if unproven.”⁴⁰

According to Patrick Lin, Maxwell Mehlman, and Keith Abney, “in changing human biology with enhancements, we also may be changing the assumptions behind existing laws of war and even human ethics.”⁴¹ If genetically modified soldiers become a thing of reality, the international consequences would be severe. This type of “mutant warfare” would cause uproar in the international arena for multiple reasons. First, opposing states are likely to feel that their security is threatened by such an obvious military advantage. Second, it is likely that many states would ethically oppose such an act against nature. The ramifications of this kind of international bad blood would be tragic.

Case Study: Cognitive/Neural Enhancement

The definition of human enhancement includes permanent and non-permanent forms of medical intervention (e.g., implants vs. supplements). A recent example of cognitive enhancement in the military is the use of amphetamines by different militaries worldwide. It is well known that the United States, Germany, England, and others used amphetamines widely during World War II, and that they were used again by the United States in Korea.⁴² According to reports, the United States continued to use amphetamines, or “speed”, during such events as Operations Desert Shield and Desert Storm.⁴³ A study done by Caldwell, Caldwell, Smythe, and Hall found that amphetamines are shown to improve performance of helicopter pilots in flight simulators.⁴⁴ The use of such performance-enhancing substances by the U.S. military proves that they are willing to take, what some would consider, extreme moves in order to improve their military.

These days, the goal seems to be 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’.”⁴⁵ According to a 2008 JASON advisory report, “the technical developments in neuropharmacology will continue to push the

⁴⁰ Moreno J. D., *Mind wars: brain research and national defense*. (Dana Press, 2006): 210.

⁴¹ Lin, Melham & Abney, *Enhanced Warfighters: Risk, Ethics, and Policy*, pp. 87.

⁴² JASON. 2008. *Human Performance*, pp. 7.

⁴³ Lin, Melham & Abney, *Enhanced Warfighters: Risk, Ethics, and Policy*, pp. 5.

⁴⁴ Lin, Melham & Abney, *Enhanced Warfighters: Risk, Ethics, and Policy*, pp. 6.

⁴⁵ Lin, Melham & Abney, *Enhanced Warfighters: Risk, Ethics, and Policy*, pp. 8.

limits of what may be achievable.”⁴⁶ The realist theory would maintain that having a military means being in the business of protecting oneself and one’s interests. If the U.S. government can get its hands on new, innovative technologies that would push the limits of what is humanly possible even further, there is no reason to believe they wouldn’t ravenously pursue it, especially if it means having a military advantage of its opponents.

In fact, according to the same JASON advisory report for the U.S. government, there is a lot of excitement surrounding the possible applications of cognitive enhancement.⁴⁷ At present, the most pressing factor of human cognitive performance that affects military effectiveness is “degradation of performance under stressful conditions, particularly sleep deprivation.”⁴⁸ This sentiment is echoed by DARPA, which states one of their program objectives to be: “... developing technologies to allow our highly skilled and impeccably trained warfighters to maintain their peak physical and cognitive performance despite harsh conditions of combat.”⁴⁹ To contend with performance degradation, DARPA is currently working on a program called Enabling Stress Resistance. This program strives “to develop and implement cognitive, behavioral, and pharmacological interventions that will prevent the deleterious effects of stress on warfighters.”⁵⁰ What this one statement can ascertain is that DARPA, and by extension the U.S. military, is researching ways to make soldiers more resilient against stress—including the use of performance-enhancing pharmaceuticals.

Sleep deprivation is a serious problem for soldiers. It is known to have a “significantly harmful impact on physical performance, alertness, and the ability to perform complex cognitive tasks.”⁵¹ DARPA is working to find a fix. The intent to establish technologies that will require warriors to spend less time sleeping without hampering their effectiveness can be seen if we examine DARPA’s 2013 budget. In 2013 DARPA plans to spend twelve million dollars on “Bio Interfaces” programs, which includes “improving our understanding of sleep-wake cycles.”⁵² The significance of sleep-related improvements is clear: “If

⁴⁶ JASON. 2008. *Human Performance*, pp. 61.

⁴⁷ JASON. 2008. *Human Performance*, pp. 1.

⁴⁸ *Ibid*

⁴⁹ DARPA, “Biology: Maintaining Human Combat Performance.” (Accessed May 29 2013).

⁵⁰ DARPA, “Enabling Stress Resistance.” (Accessed May 29 2013).

⁵¹ JASON. 2008. *Human Performance*, pp. 20.

⁵² DARPA, “Department of Defense Fiscal Year (FY) 2013 President’s Budget Submissions. Justification Book Vol. 1.” pp. 3.

an opposing force had a significant sleep advantage, this would pose a serious threat.”⁵³ The United States believes that it needs to be the first to implement sleep deprivation therapies *and* they need to do it best.

Cognitive research is currently underway aimed at enhancing many other aspects of the mind as well. DARPA’s Human Assisted Neural Devices program is aimed at strengthening and restoring memories.⁵⁴ Furthermore, DARPA is working on an artificial intelligence project called Deep Green. The purpose of the project is to enhance decision-making and planning.⁵⁵ Additionally, several research programs at DARPA are utilizing the advances in neuroscience and cognitive psychology to enhance learning abilities.⁵⁶ Some of those programs are: Neurotechnology for Intelligence Analysts, Accelerated Learning, Education Dominance, Augmented Cognition, and Training Superiority Programs.⁵⁷ These different cognitive enhancement programs are just the tip of the iceberg. There are hundreds of other government-funded research programs looking into cognitive and neural enhancement technologies.

Two of the realist assumptions apply to this case. The first assumption that applies is that states are rational actors and therefore act in their own best interest. The second assumption that applies is that states’ primary concern is survival. “Might is right” certainly seems to be the U.S. government’s belief when it comes to cognitive and neural enhancement. Although cognitive and neural enhancement might not be considered strength in the conventional sense, it certainly is an offensive and defensive military advantage. America wants to equip its soldiers with the best equipment, including cognitive functioning. If soldiers can sleep less, remember more, learn faster, and become less mentally and physically impacted by stress, they can do considerably more damage. From a military standpoint, the goal is to make organic, living beings perform like machines. As Lieutenant General E.R. Bedard states: “It is about transforming our forces to meet the new reality and retaining our dominance as the

⁵³ JASON. 2008. Human Performance, pp. 1.

⁵⁴ DARPA, “Department of Defense Fiscal Year (FY) 2013 President’s Budget Submissions.” pp. 50.

⁵⁵ DARPA, “Department of Defense Fiscal Year (FY) 2013 President’s Budget Submissions.” pp. 246.

⁵⁶ DARPA, “Department of Defense Fiscal Year (FY) 2013 President’s Budget Submissions.” pp. 163.

⁵⁷ Ibid

finest military force in the world.”⁵⁸ The impact this type of military advantage will have on the international balance of power is considerable. According to defense expert Fred Ikle, “a competitive race with China to build the first super-intelligent system might start sooner than most think tanks and government forecasters expect”⁵⁹ and “we cannot assume America would prevail.”⁶⁰

Case Study: Enhanced Materials

For the purposes of this research, we include enhanced materials/tools in the definition of human enhancement. Enhanced materials are materials designed to aid in the achievement of the above medical or biological improvements. New materials are the foundation upon which every device or system that transforms the military is built.⁶¹ The United States currently has several ongoing programs that aim at creating enhanced materials that can be used by soldiers in combat. These materials enhance the performance and endurance of soldiers in order to gain and sustain military advantage.

Continuing advances in lightweight body armor that can be worn by soldiers in combat could incorporate health monitoring and cooling.⁶² Furthermore, the United States Army has visions of a powered exoskeleton that would enable soldiers to interact with “robotics, software systems, and hardware platforms via an array of ‘third generation’ interfaces that will rely on natural language commands, gestures, and virtual display/control systems.”⁶³ These armor improvements could prolong the stamina of the warrior wearing it. As discussed above, enhanced stamina is a key goal of the United States military at this point. Furthermore, the melding of biology and materials could transform current systems or even provide new, unique capabilities. These materials intended for external use are called “bioinspired materials.”⁶⁴

⁵⁸ Bedard, E.R. “Nonlethal Capabilities: Realizing the Opportunities.” *Defense Horizons*. no. 9 (2002): pp. 6.

⁵⁹ Fred Ikle, *Annihilation from Within: Ultimate Threat to Nations*, (Columbia University Press, 2010): pp. 32.

⁶⁰ Ikle, *Annihilation from Within: Ultimate Threat to Nations*, pp. 33.

⁶¹ Zimet, Elihu, Robert Armstrong, Donald Daniel, Joseph Mait. “Defense Horizons.” *Technology, Transformation, and New Operational Concepts*. no. 31 (2003): 3.

⁶² Zimet, Armstrong, Daniel, Mait. “Technology, Transformation, and New Operational Concepts.” pp. 4.

⁶³ U.S. Army Natick Soldier RD&E Center, “Future Soldier 2030 Initiative.” Last modified February 2009: 3. (Accessed May 29 2013).

⁶⁴ Armstrong & Warner, “Biology and the Battlefield,” pp. 4.

The United Kingdom is working on enhanced materials with military applications as well. The BAE System's Q-Sight is a flight helmet that "enhances situational awareness as well as control of the aircraft, including targeting through eye movements."⁶⁵ Along the same lines, the U.S. Army Research Office, in collaboration with the University of California, Irvine, Carnegie Mellon University, and University of Maryland are working on "synthetic telepathy," which would enable communication through thought alone.⁶⁶ According to JASON, a recent DARPA proposal for an advanced imaging system includes a requirement for a brain interface capable of responding to subconscious recognition of an enemy.⁶⁷

Alternatively, there are materials intended for incorporation into a living organism. These are called "biomaterials."⁶⁸ Examples of biomaterials are those that would be used for wound healing. Wound healing is a large area of interest for the military. Take, for instance, DARPA's material program called Fracture Putty. Through this program, DARPA hopes to create an innovative "putty-like material that, when packed in and around a compound bone fracture, provides full loadbearing capabilities within days."⁶⁹ This would restore a soldier to fighting function with dramatically reduced rehabilitation time and elimination of infection and secondary fractures all while normal healing is going on internally. Reduced down time means soldiers are back fighting sooner. More manpower means more military strength and less potential for vulnerability. Furthermore, there are biomaterials that can be used to control excessive bleeding, which accounts for 55 percent of combat deaths.⁷⁰ According to Robert Armstrong and Jerry Warner, experts in military technology, combining Fibrin, the protein found in blood, and adhesive proteins found in barnacles could create "biosealants" that would slow or stop bleeding.⁷¹

When bioinspired materials and biomaterials are crossed, you have hybrid materials. These are engineered materials, but with at least on biological

⁶⁵ BAE Systems, "The Q-Sight™ family of helmet display products." 2010. (Accessed May 29 2013).

⁶⁶ Bland, Eric. "Army Developing 'Synthetic Telepathy.'" NBC News, sec. Science, October 13, 2008.

⁶⁷ JASON. 2008. Human Performance, pp. 67.

⁶⁸ Armstrong & Warner, "Biology and the Battlefield," pp. 4.

⁶⁹ DARPA. "Fracture Putty." (Accessed May 29 2013).

⁷⁰ Armstrong & Warner, "Biology and the Battlefield," pp. 4.

⁷¹ Ibid

molecule.⁷² For instance, a bacterium called bacteriorhodopsin absorbs microwave radiation at higher frequencies, plant proteins could be the basis for infrared signature reduction in paints, and certain biological systems can give us the blueprint for new structural patterns that diffract light. All of these enhanced materials can yield advanced camouflage and stealth characteristics, that when coupled with armor, enhance a soldier's capabilities.⁷³

United States General George Casey stated: "The goal of our Army is to continue the transformation process of building a campaign quality expeditionary Army that can support our combatant commanders in challenges of the 21st century across the full spectrum of conflict."⁷⁴ The implementation of enhanced materials is the exact kind of transformation in military affairs that will aid commanders in 21st century conflict. The ability of soldiers to recover from injury more quickly, perform missions without being seen, and control military devices by thought is a step toward the creation of an entirely new kind of soldier. But once again, these advances in material technology come at a large international cost. The United States is focused on maintaining its place as the best military in the world and its use of enhanced materials will certainly further this goal. However, as with the U.K., other countries are racing to create these materials as well, leaving the international balance of power hanging in the crossfire.

Implications

Since World War II, technology superiority has been a major landmark of the U.S. military.⁷⁵ As I have shown, human enhancement is one of the most rapidly growing areas of technology with military significance. Successful implementation of human enhancement technologies will give the United States, or any country that successfully harnesses them, an undeniable advantage over their opponents in warfare. They have the potential to make it easier and safer for soldiers to perform in combat but they also have the potential to disrupt the international balance of power. In the future, the strength and power of a military won't be judged purely by its size or skill, but also on the quality of

⁷² Ibid

⁷³ Zimet, Armstrong, Daniel, Mait. "Technology, Transformation, and New Operational Concepts." pp. 5.

⁷⁴ U.S. Army Natick Soldier RD&E Center, "Future Soldier 2030 Initiative." pp. 1.

⁷⁵ Zimet, Armstrong, Daniel, Mait. "Technology, Transformation, and New Operational Concepts." pp. 8.

its enhanced soldiers. According to experts,⁷⁶ “a weapon system can no longer be evaluated or enhanced in isolation from its human operator.”⁷⁷ Soldiers are becoming a part of the weapon. In short, “the complexity of combat has increased, and with it the tempo of operations.”⁷⁸

The international implications are likely to be two-fold. On the one hand, countries that can afford to develop these technologies will all be racing against each other to develop human enhancement technologies the fastest and most efficient ways possibly. The likely result is an HET arms race between the wealthiest countries in the world. In the past, arms races have had favorable results for advancing military technologies. However, hasty implementation before a technology has been adequately tested or refined can have deadly consequences. This is especially true when human beings are an integral part of the technology.

The United States isn't the only country pursuing human enhancement technology. China and Russia are likely to move much more quickly on this technology than most other countries, but it is unlikely that other international actors will be as open as the U.S. about what they are doing. The advantage this technology provides will not likely go unnoticed. There is a potential threat “for adversaries to exploit advances in Human Performance Modification, and thus create a threat to national security.”⁷⁹ In creating new technologies that benefit a state, you're opening up that technology for potential proliferation. Once it has been created, unless there is a standing governing body to police it, there is no way of controlling who will get their hands on it. According to David Axe, “it's equally hard to tell to which terrorists, militants and criminal groups these countries might have ties—and whether new biological weaponry might proliferate these channels.”⁸⁰ With a lack of transparency, international mistrust is likely to stew.

⁷⁶ Jack L. Blackhurst is the director of the Air Force Research Laboratory Human Effectiveness Directorate. Jennifer S. Gresham is a visiting research scholar at the Florida Institute for Human and Machine Cognition. She previously served 16 years in the Air Force and is a reservist for the Air Force Office of Scientific Management. Morley O. Stone is the chief scientist of the Human Performance Wing at the Air Force Research Laboratory.

⁷⁷ Blackhurst, Jack, Jennifer Gresham, and Morley Stone. “The Quantified Warrior: How DoD should lead human performance augmentation.” *Armed Forces Journal*. (2012).

⁷⁸ Jason. 2008. *Human Performance*, pp. 7.

⁷⁹ Jason. 2008. *Human Performance*, pp. 7.

⁸⁰ Axe, David. “This Scientist Wants Tomorrow's Troops to Be Mutant-Powered.” *WIRED*, sec. Science.

The second potential implication deals with the relationship between the haves and the have-nots. Countries that aren't one of the first several to implement human enhancement technologies in the military are likely to feel threatened by the increasing gap between their military power and the military power of countries with HET. The increase in power may seem like a provocation. Thus, in the 21st century the development of human enhancement technology may also trigger a security dilemma between less technologically developed countries and superpowers like the U.S.

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