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14. ABSTRACT

This paper develops a neuroethical framework to address the implications of invasive neurotechnology being utilized on able-bodied individuals for human enhancement in the name of national defense. Neurotechnology can positively alter the lives of millions of people with physical abnormalities or psychological disorders. However, it can also change what it means to be human for a healthy soldier. It is unlikely that researchers can identify all of the possible second and third-order consequences of invasive neurotechnology before implanting it in soldiers. This is why ethicists must stay one step ahead of development and work closely with researchers and government agencies to minimize unintended consequences. Neurotechnology has numerous national security implications and the potential to change the character of war depending on how it is incorporated. In particular, invasive neurotechnology has increased risks and costs but yields tremendous benefits if it is developed using an ethics-first approach to limit unintended consequences to humanity and society. Militarizing invasive neurotechnology must not be solely for an asymmetric advantage. Although this technology is still in development, it is important to explore all possibilities to allow the ethical discourse to get ahead of the implementation. The Ethical, Legal, and Social Implication (ELSI) panels in neurotechnology research establishments need to have the ultimate authority on whether neurotechnology research on able-bodied humans should continue or end before unintended consequences occur.

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U.S. NAVAL WAR COLLEGE
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A Neuroethical Framework to Analyze Soldier Enhancement Using Invasive Neurotechnology

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A paper submitted to the Faculty of the United States Naval War College Newport, RI, in partial satisfaction of the requirements of the curriculum.

Introduction

Soldier enhancement using invasive neurotechnology requires an ethics-first approach from the soldier's perspective to prevent more harm than good. Militarizing invasive neurotechnology must not be solely for an asymmetric advantage. Neurotechnology has numerous national security implications and the potential to change the character of war depending on how it is incorporated. In particular, invasive neurotechnology has increased risks and costs but yields tremendous benefits if it is developed using an ethics-first approach to limit unintended consequences to humanity and society. Neurotechnology is at the forefront of development for private companies, academics, and medical researchers, and for good reason. Neurotechnology can positively alter the lives of millions of people with physical abnormalities or psychological disorders that prevent them from integrating into society. It would be a remarkable feat to alleviate the pain and anguish of individuals with debilitating neurological disorders by implanting a chip. Neurologists can implant a brain-computer interface (BCI) device that works with a prosthetic limb to provide movement for individuals who were born with a physical disability or suffered a traumatic injury. Not only does the device provide movement, but it also can provide the sensation of touch. The same device that allows a human and a machine to communicate through thought may also enable two humans to communicate without speaking or seeing each other.

However, this rapid technological growth comes with risks. Will the ethical and legal oversight move fast enough to keep up? If not, it leads to the potential for dual-use development where ethically approved neurotechnology is used for human enhancement in ways that were not originally intended. Human enhancement involves using technology to enhance natural features

or capabilities in a way that provides an advantage physically, psychologically, or intellectually.[1] Neurotechnology used in this way could be considered unethical since it will alter humanity in unintended ways. In some applications, this technology merges humans with machines. It can potentially change the definition of what it means to be human and how a human interacts with the world.

From an ethical standpoint, neurotechnology is one of the more concerning technologies that could be implemented in military operations due to the potential impact on human nature itself. The pace at which these new technologies are being developed leads many to question whether ethical oversight is sufficient to minimize the risk of unintended consequences as these weapons are implemented into military operations. The DOD Biotechnologies for Health and Human Performance Council found that "current security and ethical frameworks are insufficient" to keep pace with these emerging technologies, so DOD needs to develop "forward-leaning policies."[2] Jean-François Caron, professor of political science and international relations, surmised that "we are probably about to enter a new paradigm as the wars of tomorrow run the risk of being carried out by 'super soldiers' with physical and cognitive capabilities that currently belong to the world of science fiction and comic books…but surprisingly remains neglected by ethicists…"[3] Although this technology is still in development, and no one can say for sure how long it will be before human enhancement can reach this level, it is important to explore all possibilities to allow the ethical discourse to get ahead of the implementation. Due to the

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[1] Jean-François Caron, *A Theory of the Super Soldier: the Morality of Capacity-Increasing Technologies in the Military*, Manchester: Manchester University Press, (2018): 10 https://doi.org/10.7765/9781526117786.
[2] Peter Emanuel et al., Cyborg Soldier 2050: Human/Machine Fusion and the Implications for the Future of the DOD, (2019), 14, https://apps.dtic.mil/sti/pdfs/AD1083010.pdf.
[3] Caron, "Super Soldier," 4.

potential impacts of these technologies on human nature, this paper examines the militarization of neurotechnology through an ethical, human, and medical perspective framework.

This paper develops a neuroethical framework to address the implications of invasive neurotechnology being utilized on able-bodied individuals for human enhancement in the name of national defense. The following thought experiments are designed to demonstrate the possibilities. Although they may seem like they are from the latest science fiction book or movie, neurotechnology research is quickly developing the technologies capable of achieving these lofty feats.

Psychological Enhancement

Imagine there is an individual who suffers from stress, anxiety, and fear, not the traditional issue that you can muscle through with extra sleep or a pep talk. This is an extreme psychological disorder that prevents them from living a traditional life. They can't keep a job. They can't develop relationships with others. They have tried every medication possible to alter their brain chemistry, but nothing has made a difference. Researchers have developed a neural network implant that can be inserted inside the brain to read brain activity and regulate stress, anxiety, and fear to allow the individual to regain control of their life. They can function normally without anyone knowing that they are being assisted by an implant automatically administering stimulation to prevent their debilitating emotions.

Now imagine applying that same neural network to a military member with no diagnosed psychological disorder. The implant can autonomously read the soldier's emotional state to ensure it is not a limiting factor in the execution of a mission. This allows the soldier to maintain complete focus on the objective. They are not feeling anxiety or an adrenaline rush before

kicking down doors in Afghanistan. They are not experiencing the stress of bullets whizzing by their head or explosions occurring nearby that could wear down their mental acumen and lead to early exhaustion. They do not succumb to the fear of death that can be debilitating in war. They can function on a mission without the concern of emotions clouding their judgment or delaying their actions which could ultimately lead to their death. Their fight or flight response has an override mechanism to manage the adrenaline. Commanders can rely on these enhanced soldiers to stay focused on a mission, achieve the objective, and return home safely to their families.

Platform Enhancement

Imagine an individual who was in a car accident and suffered paralysis from the neck down. They have lived most of their life stuck in a wheelchair relying on the assistance of family and friends. Even the most basic things, like eating and bathing, are no longer basic and require many helping hands. The individual was ecstatic to learn that wheelchair technology had become motorized, and they could use their mouth to pilot the chair giving a small sense of freedom back to their life. As technology improved, so did the possibilities. Now a BCI chip can be implanted in their brain that allows them to control robotic appendages and even feel the sensation of touch on mechanical fingertips. The possibilities of the individual's "new" capabilities are endless. The wife might be able to dance with her husband again. The father might be able to walk his daughter down the aisle. The little boy might be able to play with his friends again.

Now imagine this same BCI chip implanted into a service member's brain that allows them to control a fighter jet with their mind.[4] In fact, they can control multiple jets from afar using a virtual reality (VR) setup that isn't so virtual. The pilot peers into what seems like a

[4] Nick Stockton, "Woman Controls a Fighter Jet Sim Using Only Her Mind," WIRED, last modified March 5, 2015, https://www.wired.com/2015/03/woman-controls-fighter-jet-sim-using-mind/.

video game, but it is no game. It's real fighter jets, real enemy jets, and real pilots in the other cockpits. However, the autonomously controlled aircraft is no longer restricted to the limitations of the human body in the cockpit, but the human remains in the loop of the decision-making process of whether to fire a weapon and take a life. Now it can be done from the comfort of their VR setup in a remote office space or an underground bunker. Unlike unmanned aerial vehicle operators, the BCI operator has direct control over the entire operation. But why stop with an aircraft? The chip also has the ability to control humanoids. An army of humanoid soldiers can go to war under the control of a few operators that control their every action. Why develop a human super soldier that can still be killed in action when you can have robotic soldiers controlled by humans?

These scenarios illustrate how the military integration of invasive human enhancement can satisfy the ultimate goal of nations sending troops into combat – achieve your political objective while preventing the unnecessary loss of life. However, the scenarios do not elaborate on the ethical, moral, and human aspects of this invasive neurotechnology. Some of the natural emotional responses to warfare are valuable in making tactical decisions and should not be dismissed. Should the military research this technology for soldiers on the battlefield? What are the repercussions or unintended consequences of this technology, and are they being considered?

Chapter 1 – Rise of Neurotechnology

Race to Development – BRAIN Initiative

The race to understand the brain by mapping out how it functions rapidly accelerated in March 2013 when President Barack Obama "announced the launch of the BRAIN (Brain Research through Advancing Innovative Neurotechnologies) Initiative – a bold, new initiative focused on revolutionizing our understanding of the human brain."[5] The initiative's goal was to follow in the footstep of the Human Genome Project by allocating government funding for scientific breakthroughs in brain research and the development of neurotechnologies. In response to the president's initiative, the National Institutes of Health (NIH) developed a scientific committee that developed BRAIN 2025: A Scientific Vision,[6] which set goals for a way forward over the next 12 years to advance neuroscience. NIH developed a team of experts across "the Defense Advanced Research Projects Agency (DARPA), the National Science Foundation (NSF), the U.S. Food and Drug Administration (FDA), and the Intelligence Advanced Research Projects Activity (IARPA)"[7] to ensure that research was done collaboratively towards achieving the goals of the program. The program laid out numerous goals which would be guided by 7 core principles. Ethics was mentioned as the sixth principle:[8]

> 6. Consider ethical implications of neuroscience research. BRAIN Initiative research may raise important issues about neural enhancement, data privacy, and appropriate use of brain data in law, education and business. These important issues must be considered in a serious and sustained manner. BRAIN Initiative research should hew to the highest ethical standards for research with human subjects and with non-human animals under applicable federal and local laws.

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[5] White House, "The Brain Initiative," accessed April 8, 2023, https://obamawhitehouse.archives.gov/BRAIN.
[6] National Institutes of Health, BRAIN 2025: A Scientific Vision, June 5, 2014, https://braininitiative.nih.gov/sites/default/files/pdfs/brain2025_508c.pdf.
[7] National Institutes of Health, BRAIN 2025.
[8] National Institutes of Health, BRAIN 2025.

Given the potential for dual use of neurotechnologies and the pace at which the technologies would advance, there are a few concerns with this statement. First, it was number six on the list behind "pursue human studies and non-human models in parallel" and "validate and disseminate technology."[9] Second, using the terms "consider" and "should" leaves the statement ineffective and up to interpretation. Given the severity of not following ethical principles in brain research, the team could have used stronger language, such as "must," which would have been more forceful.

President Obama's BRAIN Initiative provided the guidance and funding for researchers to not only explore the brain and how it works but develop ways to improve its functionality and restore capability to people with disabilities. The level of invasiveness will determine the effects of neurotechnology and what potential it has for monitoring and enhancing brain function.[10]

Invasive vs Noninvasive Neurotechnology

The neurotechnology introduced in this paper can be categorized by two distinct features. The devices can be either invasive or noninvasive. Technically there is a semi-invasive option for neurotechnology, but since it relies on a craniotomy, this study considers it invasive. Noninvasive neurotechnology consists of a cap or multiple sensors that are placed on the head of the patient and measure activity through the skull. Although this technique is effective, there are limitations related to the spatial and temporal resolution of the data.[11] Semi-invasive relies on a craniotomy to bypass the skull and place a network of sensors directly on the brain without penetration. This bypasses the resolution issues of noninvasive neurotechnology but can't target

[9] National Institutes of Health, BRAIN 2025.
[10] Nitish S Jangwan et al., "Brain Augmentation and Neuroscience Technologies: Current Applications, Challenges, Ethics and Future Prospects," *Frontiers in Systems Neuroscience* 16 (2022): 2, https://doi.org/10.3389/fnsys.2022.1000495.
[11] Jangwan, "Brain Augmentation," 5.

specific brain regions. Invasive neurotechnology provides access to specific brain regions by using an electrode for targeted deep brain stimulation.

Transcranial stimulation was developed to provide the ability to monitor and record brain activity to determine brain activity during a seizure and to isolate any abnormal behavior. It developed the capability to stimulate the brain to regulate brain activity utilizing external sensors. Two prominent forms of transcranial stimulation are electroencephalogram (EEG) and functional magnetic resonance imaging (fMRI). The EEG sensors record brain activity at a high temporal resolution, but the spatial resolution is low.[12] The fMRI is a larger, more expensive unit that has the ability to detect changes in blood flow at a higher temporal resolution but also low spatial resolution.[13] To account for the noninvasive inability to provide a higher spatial resolution, invasive neurotechnology was developed, meaning probes or chips are implanted directly in the brain to gain measurements.

Two options currently in research for invasive neurotechnology are Deep Brain Stimulation (DBS) and adaptive Deep Brain Stimulation (aDBS). According to Lozano et al., "DBS is a neurosurgical procedure that involves the implantation of electrodes into specific targets within the brain and delivery of constant or intermittent electricity from an implanted battery source."[14] DBS has been developed to treat multiple disorders impacting motion, cognition, emotion, and psychological state.[15] aDBS has the capability to "read and write to the

[12] Jangwan, "Brain Augmentation," 5.
[13] Jangwan, "Brain Augmentation," 5.
[14] Andres M. Lozano et al., "Deep Brain Stimulation: Current Challenges and Future Directions," *Nature Reviews, Neurology* 15, no. 3 (2019): 148, https://doi.org/10.1038/s41582-018-0128-2.
[15] Lozano, "Deep brain stimulation," 148.

brain."[16] It can record neural activity and then stimulate a portion of the brain to manage movement associated with Parkinson's disease, seizures, and psychiatric disorders.[17]

Commercializing Neurotechnology

Medtronic[18] received Food and Drug Administration (FDA) approval in 1997 for neurotechnology stimulation devices to treat Parkinson's disease. The company has successfully developed brain-sensing technology that identifies frequency bands in the brain for Parkinson's patients. It works by combining a Percept PC neurostimulator with the BrainSense technology to identify when a patient is having mobility challenges and stimulate a specific region of the brain to allow for normal function. The system is implanted in the patient's brain and can autonomously deliver stimulation. Brain activity is recorded for medical analysis of therapeutic response to the stimulation and event correlation.

NeuroPace[19] received FDA approval in 2013 for a brain implant device to reduce the occurrence of seizures in patients with epilepsy. The implant monitors brain activity and analyzes for an abnormality associated with a seizure. It then provides stimulation to reduce the impacts of the seizure or stop them from occurring. All activity is recorded for analysis to determine seizure correlation with other activities or medications.

Blackrock Neurotech[20] has dubbed itself the "leader in brain-computer interface technology" for its developments over the past two decades. Their technology provides the

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[16] Lozano, "Deep brain stimulation," 148.
[17] Kristin Kostick-Quenet et al., "Researchers' Ethical Concerns About Using Adaptive Deep Brain Stimulation for Enhancement," *Frontiers in Human Neuroscience* 16 (2022): 1, doi:10.3389/fnhum.2022.813922.
[18] Medtronic, "BrainSense Technology," last modified June 2022, https://www.medtronic.com/us-en/healthcare-professionals/products/neurological/deep-brain-stimulation-systems/brainsense.html.
[19] NeuroPace, "There's a Smarter Way to Treat Epilepsy," accessed April 8, 2023, https://www.neuropace.com/.
[20] Blackrock Neurotech, "The Leader in Brain-Computer Interface," accessed February 14, 2023, https://blackrockneurotech.com/.

ability to customize the electrode interface and integration to treat 10 different neurological disorders, from anxiety and depression to paralysis and Parkinson's disease. Their NeuroPort Array technology has allowed people to move again, talk again, and feel again. This technology became infamous during a 2016 press conference when Nathan Copeland, who had suffered a spinal cord injury, used his thought-controlled prosthetic hand to fist-bump President Barack Obama.

Syncron[21] received FDA approval to begin human trials in 2021 for the strentrode, a minimally invasive stint electrode network, for neuroprosthetics, neuromodulation, and neurodiagnostics. It was designed to minimize the potential for brain swelling or brain trauma. The technology called Neurointerventional Electrophysiology, or Neuro EP for short, is a neurovascular BCI that utilizes blood vessels throughout the brain to treat multiple neurological diseases. The technology can restore function to a patient suffering from paralysis, provide deep brain stimulation for an epilepsy patient, and record brain activity to identify any abnormal brain functionality.

Neuralink[22] was founded in 2016 to develop an invasive BCI using a link and small-scale threads throughout the brain that control a computer or mobile device. The company has received notoriety thanks to its owner and visionary, Elon Musk. The neural network is so meticulous that it requires the precision of a robotic system to insert the threads into the brain. The device is also unique because the link mechanism uses a lithium-ion battery and has wireless charging capability. It has yet to receive FDA approval but has the potential to push neurotechnology boundaries for continued research.

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[21] Synchron, "Unlocking the Natural Highways of the Brain," accessed April 8, 2023, https://synchron.com/.
[22] Neuralink, "Breakthrough Technology for the Brain," accessed February 14, 2023, https://neuralink.com/.

Dual-Use Dilemma – Invasive Neurotechnology

With all new technologies, there is a concern from researchers that their devices could have a dual-use potential and become utilized for reasons that were not originally intended. The dual-use dilemma is created when a conflict between ethical norms is realized: "the promotion of good and the prevention of possible collateral harm."[23] In many cases, this dual-use is benign and instead advances the original technology into something greater. However, there is also the possibility that the original device is transformed into something unintended that causes harm or unforeseen risks to society. The original device passes all the ethical, legal, and moral lenses, which creates an opportunity to transform the device, potentially without critical oversight. What are the possibilities for transforming invasive neurotechnology into something unintended? Will it be possible to take control of the implanted device to negatively impact the patient's ability to function cognitively? What are the repercussions on society? There is also the possibility that the technology falls into the wrong hands. Its disruptive potential makes it a target for adversaries to use for their own objectives or attack their vulnerabilities. These considerations are why ethicists need to stay one step ahead of the development and work closely with researchers and government agencies to minimize unintended consequences.

Why Militarize Neurotechnology

Most of the possibilities in neurotechnology sound like science fiction but technological advancement throughout history has shown that we have the creativity and the perseverance to turn science fiction into reality. Besides, the benefits are obvious, but are they worth the potential costs for human enhancement? Imagine a war where neurotechnology is combined with robotics,

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[23] Marcello Ienca, Fabrice Jotterand, and Bernice S. Elger, "From Healthcare to Warfare and Reverse: How Should We Regulate Dual-Use Neurotechnology?," *Neuron* 97, no. 2 (2018): 270, doi:10.1016/j.neuron.2017.12.017.

and the soldiers are controlling machines from a safe location using virtual reality to see the battlefield from the machine's perspective in real-time. A device capable of achieving this has already been developed, called Human Assisted Neural Device (HAND), which allows a soldier to control a robot with a neural connection.[24] Neurotechnology devices that use a BCI like HAND combine human and computer traits to maximize the warfighter's capabilities. The computer is able to collect and process data, communicate, and conduct surveillance while the human remains in the loop for problem-solving, tactical decisions, and moral agency, responsible for military action.[25] Neurotechnology also provides the ability to communicate brain to brain using thoughts. In a military scenario, this could allow covert command and control that bypasses traditional communication methods.[26]

There are military psychological benefits for neurotechnology as well. Researchers have learned "that medical and psychological problems deriving from military missions – such as stress and fatigue – often have deadly consequences even for the best-trained soldiers."[27] Imagine if military commanders had the capability to write directly to a soldier's brain while on a mission to shield them from fear, anger, or shame. Would that allow you to remove unwanted thoughts and memories from the soldier's brain to protect them from reliving a traumatic event in the future? Some neurotechnology "research [is] designed to erase certain events from the memory of soldiers to prevent post-traumatic brain disorder"[28] It is estimated that 14-16% of military personnel who are exposed to combat operations experience PTSD at some point in their

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[24] Nicholas Evans, "Emerging Military Technologies: A Case Study in Neurowarfare," in *New Wars and New Soldiers: Military Ethics in the Contemporary World*, ed. Jessica Wolfendale and Paolo Tripodi (Surrey: Ashgate Publishing, 2013), 106.
[25] Evans, "Emerging Military Technologies," 108.
[26] Robert C. Bruner, and Filippa Lentzos, "Militarising the Mind: Assessing the Weapons of the Ultimate Battlefield," *BioSocieties* 14, no. 1 (2019): 107, https://doi.org/10.1057/s41292-018-0121-4.
[27] Caron, *"Super Soldier,"* 29.
[28] Caron, *"Super Soldier,"* 3.

life.[29] Would neurotechnology aimed at altering or eliminating the memories of service members help fix PTSD? Researchers are "actively involved in developing technologies and drugs with the goals of altering – sometimes permanently – the internal physical faculties of individuals as well as their cognitive abilities."[30]

Another argument can be made that other countries are similarly trying to develop neurotechnology, which results in an asymmetric advantage in warfare and threatens American national security. When the BRAIN initiative started in 2013, many countries around the world announced a similar initiative to explore the brain. Over the past decade, China, Korea, Canada, Japan, Australia, and the European Union have created brain research projects.[31] In the 2022 National Security Strategy, President Biden stressed the importance that the US and its allies must lead future technological innovation to establish global "institutions, norms, and standards."[32] To establish rules and norms associated with human enhancement, the United States must ensure that it is the first to develop the technology. Numerous foreign militaries have started to develop neurotechnology to increase cognition and capabilities, and BCI's capable of enhancing psychological or physical weaknesses.[33] For example, China began its China BRAIN Project in 2013 in response to the US BRAIN Initiative to develop what they call the "two wings," the crossroads between brain science and artificial intelligence.[34] China views this

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[29] Margaret A. Gates et al., "Posttraumatic stress disorder in veterans and military personnel: Epidemiology, screening, and case recognition," *Psychological Services* 9, no. 4 (2012): 1, doi:10.1037/a0027649.
[30] Caron, "*Super Soldier*," 3.
[31] Margaret Kosal, and Joy Putney, "Neurotechnology and International Security: Predicting Commercial and Military Adoption of Brain-Computer Interfaces (BCIs) in the United States and China," *Politics and the Life Sciences* 42, no. 1 (2023), 1, https://doi.org/10.1017/pls.2022.2.
[32] White House, *National Security Strategy of the United States of America* (Washington, DC: White House, 2022), 32-3, https://www.whitehouse.gov/wp-content/uploads/2022/10/Biden-Harris-Administrations-National-Security-Strategy-10.2022.pdf.
[33] Caron, "*Super Soldier*," 3.
[34] Elsa B. Kania, "Minds at War: China's Pursuit of Military Advantage through Cognitive Science and Biotechnology," *Prism (Washington, D.C.)* 8, no. 3 (2019): 89.

scientific competition as a military competition in the offensive and defensive realm with the goals "to imitate the brain, leverage brain control, enhance the brain, or control the brain."[35] Militarized neurotechnology provides China with achieving its goal to win without fighting as they promote "informatized warfare, conflict in the cognitive domain attempts to undermine the adversary's will and resolve, undermine perception and command capabilities to weaken fighting spirit, and manipulate decisionmaking."[36] Although this approach is concerning and warrants developing capabilities to counter a competitor's neurotechnology, it must not come at the expense of US service members or by sacrificing morals, norms, or laws.

The U.S. Army published the findings of a technology research assessment conducted by DOD Biotechnologies for Health and Human Performance Council called "Cyborg Soldier 2050: Human/Machine Fusion and the Implications for the Future of the DOD," in which they identified militarily useful technologies most likely to be developed by or before the year 2050.[37] The study identified the enhancement capabilities that would be most impactful and ranked them[38]:

1. situational awareness,
2. strength and speed,
3. imaging and sight,
4. communication,
5. physiology (endurance/sleep/health),
6. virtual (avatar) control,
7. attention and memory,
8. learning, and
9. olfaction (sense of smell).

[35] Kania, "Minds at War," 87.
[36] Kania, "Minds at War," 87.
[37] Emanuel, Cyborg Soldier 2050, v.
[38] Emanuel, Cyborg Soldier 2050, 2.

One research goal was the "Direct Neural Enhancement of the Human Brain" to achieve "rapid and integrated control of multiple assets by the enhanced operator, thus improving battlefield awareness and warfighter lethality."[39] The panel referenced that this "neural enhancement through implantation of modulatory electrodes in the brain will allow for rapid interaction between machine and operator through a read/write type of mechanism."[40]

Current DARPA Programs

DARPA links scientific research and the Department of Defense's national security requirements. DARPA began neurotechnology research as far back as the 1960s as a way to improve human performance by linking humans and machines together. Although their neuroscience research has continued since then, it rapidly expanded after President Obama's BRAIN initiative announcement. Their pursuit of dual-use technology to improve resources for national security is in BCIs, warfighter enhancement using neurotechnology, and detecting deception in interrogations.[41] Currently, DARPA has numerous research projects exploring the brain and how to use its functionality to interact with the world in an improved manner. DARPA's Chief of Staff stated that they employ an Ethical, Legal, and Social Implication (ELSI) panel for every program to ensure that their research and development meet acceptable U.S. standards.[42] A few of their current research projects that intersect with the neurotechnology introduced in this paper are[43]:

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[39] Emanuel, Cyborg Soldier 2050, 7.
[40] Emanuel, Cyborg Soldier 2050, 7.
[41] Ienca, Jotterand, and Elger, "From Healthcare to Warfare and Reverse," 269.
[42] Joseph Whited, "Ethics of Technology: A DARPA Perspective," PowerPoint presentation, Naval War College, Newport, RI, April 3, 2023.
[43] DARPA, "DARPA and the Brain Initiative," accessed February 17, 2023, https://www.darpa.mil/program/our-research/darpa-and-the-brain-initiative.

Hand Proprioception and Touch Interfaces (HAPTIX)

The HAPTIX program aims to create fully implantable, modular and reconfigurable neural-interface microsystems that communicate wirelessly with external modules, such as a prosthesis interface link, to deliver naturalistic sensations to amputees.

Next-Generation Nonsurgical Neurotechnology (N^3)

The N^3 program aims to develop a safe, portable neural interface system capable of reading from and writing to multiple points in the brain at once. Whereas the most advanced existing neurotechnology requires surgical implantation of electrodes, N^3 is pursuing high-resolution technology that works without the requirement for surgery so that it can be used by able-bodied people.

Restoring Active Memory (RAM)

The RAM program aims to develop and test a wireless, fully implantable neural-interface medical device for human clinical use. The device would facilitate the formation of new memories and retrieval of existing ones in individuals who have lost these capacities as a result of traumatic brain injury or neurological disease.

Restoring Active Memory – Replay (RAM Replay)

The RAM Replay program investigates the role of neural "replay" in the formation and recall of memory, with the goal of helping individuals better remember specific episodic events and learned skills. The program aims to develop novel and rigorous computational methods to help investigators determine not only which brain components matter in memory formation and recall, but also how much they matter.

Systems-Based Neurotechnology for Emerging Therapies (SUBNETS)

The SUBNETS program seeks to create implanted, closed-loop diagnostic and therapeutic systems for treating neuropsychological illnesses.

There are numerous neurotechnology programs in research and development throughout industry, academia, and the military. With all these programs looking to explore the potential use of neurotechnology, how can we be sure that they stay within the bounds of established morals, norms, and humanity? How do we ensure that the potential good is maximized while limiting the bad? The following section explores an ethical framework for discourse on implementing neurotechnology that can also be applied to other human-centric technologies.

Chapter 2 – Neuroethical Framework for Evaluation

The human enhancement of military soldiers raises a spirited debate. The ethical dilemma is that the military has a duty to protect the lives of its service members while also ensuring they retain moral agency to challenge unethical orders.[44] Is it possible to do both? Can we protect the humanity and the free will of an enhanced soldier while enhancing natural capabilities to protect them from harm? Although Ethical, Legal, and Social Implication (ELSI) panels exist in government and academia, are they enough to identify and preclude societal harm? The following evaluation sheds some light on this debate.

Ethical Lens[45]

Utilitarianism – Deontology – Ethics of Care

Ethics can be defined as a framework to discuss moral decision-making through different lenses. The ethics framework associated with neurotechnology has been named *neuroethics*, similar to bioethics for biotechnology. These fields have been narrowed from the broader medical ethics framework to get ahead of the technology to ensure ethics are incorporated early, which should reduce unintended consequences. It is critical that neuroethics governs technological implementation rather than playing catchup due to the severe consequences of neglecting it. It is critical that ethicists are outspoken over their concerns for the implications in research and development of neurotechnology since ignoring them negatively affects humanity and society.[46] Some may argue that strictly adhering to neuroethics oversight hinders

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[44] Caron, "*Super Soldier*," 63.
[45] For additional ethical resources, please see the Markkula Center for Applied Ethics website at Santa Clara University, https://www.scu.edu/ethics/ethics-resources.
[46] Caron, "*Super Soldier*," 4.

neurotechnology and, therefore, US national security, but history has shown us that the military, which operates under ethical norms and laws, prevails in war.[47]

This paper uses three main lenses to evaluate the morality of military implementation of invasive neurotechnology on the battlefield. The utilitarian lens evaluates this neurotechnology based on its potential results and whether it limits the negative impacts associated with war. This lens will also attempt to futurize this technology to discuss second and third-order effects that would impact the utilitarian view. The deontological lens will evaluate each of the technologies based on the intentions rather than the results. This lens will attempt to determine whether it is ethical based on the duty requirements of a military organization to protect its service members. The final lens is the ethics of care which is an empathetical view of this technology's impact on the service member and their family.

Utilitarianism

A utilitarian or consequentialist would look at the consequences of invasive neurotechnology to determine if it is justified. Most importantly, the consequentialist view emphasizes that only consequences count, and intentions are irrelevant.[48] Therefore, technology is morally acceptable if the good outweighs the bad consequences.[49] This type of human enhancement has the potential for the military to do more with less. Victory in war has mostly been achieved with mass at the critical point to defeat the enemy's center of gravity. However, this exposes many soldiers to the impacts of war and potential death. Utilizing capacity-increasing technologies allows soldiers to operate at a higher level in dangerous situations with

[47] P. W. Singer, "The Ethics of Killer Applications: Why Is It So Hard To Talk About Morality When It Comes To New Technology?," in *Military Ethics and Emerging Technologies*, ed. Timothy J. Demy, George R. Lucas Jr., and Bradley J. Strawser (London: Routledge, 2016), 15.
[48] Lawrence M. Hinman, *Ethics: A Pluralistic Approach to Moral Theory* (Boston: Cengage Learning, 2012), 124.
[49] Hinman, *Ethics,* 124.

less fatigue; therefore, it would allow the military to accomplish more with fewer personnel which would reduce the overall traumatic exposure.[50] A nation could send a smaller contingent of human-enhanced soldiers, therefore, exposing fewer people to trauma, injury, or death. However, this only accounts for what occurs while in battle. What are the long-term results of the technology's impact on the soldiers? Neurotechnology may allow them to be more effective in war, but will they lose the ability to be a productive member of society once they return? If they can't reintegrate, the second-order effects would impact the families and friends of these service members. Instead of the families of the deceased being negatively impacted by the war, now it would be the family of every returning enhanced service member. If this is calculated out to the negative impacts on society, then the numbers would not support using invasive neurotechnology as a soldier enhancement.

One of the limitations of using utilitarianism as the only ethical discourse is the difficulty of identifying second and third-order consequences that are critical to determining whether a technology is justified. The initial effects of a particular technology may be positive when utilized as intended; however, the continued use of the technology may create other adverse effects that were not intended. For example, during World War 1, trench warfare was developed as a way to protect soldiers from enemy fire on the battlefield, so the intended consequence was protection. This would be considered a moral good and hard to argue against. The unintended consequence was that the trenches kept soldiers trapped in one place, so it resulted in no significant movement and became a war of attrition, which led to an increased number of deaths during the war. Another challenge for utilitarians is how to account for impacts on future

[50] Caron, *"Super Soldier,"* 29

generations.[51] Since invasive neurotechnology can potentially change what it means to be human, there is little doubt that it will affect future generations. How to account for this is challenging but necessary. Therefore, one must be cautious when only considering utilitarianism to determine whether a technology is ethical.

Another argument against using utilitarianism as a lens for determining whether invasive neurotechnology is ethical or not is that its result would be decided based on calculating the human lives being affected. This can be viewed as a calculated but emotionless approach to analyzing the decision. The military has gone to great lengths to humanize service members and not use them only as a means to an end. Taking a utilitarian approach may result in an ethically approved decision to implement invasive neurotechnology on the battlefield, but it would be viewed through the lens of ones and zeroes, which is counter to the service's humanizing approach.

Deontology

A deontologist or Kantian ethicist wouldn't consider the consequences but only the intentions of the action and if there is an obligation based on duty or laws. Through a Kantian lens, the military should not introduce invasive neurotechnology if it can potentially alter that person's humanity. Kant says that "we should act in such a way that you always treat humanity, whether in your own person or in the person of any other, never simply as a means, but always at the same time as an end."[52] Does the military have a moral obligation or duty to develop technologies that protect soldiers on the battlefield while also developing technologies that allow

[51] Hinman, *Ethics*, 139.
[52] Immanuel Kant, *Groundwork for the Metaphysics of Morals* (New Haven: Yale University Press, 2008), 66.

armies to win wars? Most would agree that the answer to this question is yes, especially if you have a loved one serving in the military.

The military has an obligation to protect its soldiers and give them every opportunity to survive a war. Therefore, it could be viewed that the DOD has a moral obligation to allow service members to benefit from capacity-increasing technologies that are designed to reduce the impacts of war, improve their health and, potentially, save their lives.[53] However, Kantian ethics also "implies that the military has a universal non-contingent moral imperative to never perform an act that would result in using its members as pawns or tools."[54] So how do you compromise between the two? Military members are currently used to wage war against other nations and organizations. What makes this permissible? One could argue that there are a few contributing factors. First, in the United States, it is an all-volunteer force, and service members are aware when they sign the contract that they could be sent into battle. Second, the military goes to great lengths to prepare service members through training, drills, and planning to increase their likelihood of survival. Lastly, the military cares for and looks after its service members during their time of service and afterward. This last point is where there is an ethical consideration that is different. What does care for an enhanced soldier look like, and how do we make sure they are cared for after they leave the service? Could a psychological enhancement actually reduce the negative mental impacts of war? Is it possible to reduce or eliminate PTSD through invasive neurotechnology? Caron argues that "if it is common knowledge that many soldiers deployed in combat zones return home mentally disabled and unable to lead normal lives afterwards, then it can be argued that not acting in order to limit or prevent such a situation, despite having the tools

[53] Caron, *"Super Soldier,"* 25
[54] Caron, *"Super Soldier,"* 5

to do so, would be tantamount to a form of negligence and a lack of respect for the soldiers as human beings able to pursue happiness in the way they want to."[55]

One of the criticisms against using deontology that could be applied to a military scenario is the excuse that the service member was just following orders, so their actions were justified.[56] This is a critical consideration for the integration of neurotechnology since it is likely that enhanced soldiers will be used in warfare. Regardless of the enhancement and ability to control their emotions, they must retain moral agency and the right to reject mission tasking if it violates ethical principles.

Ethics of Care

The ethics of care lens focuses on the individual and not the greater impact on society. It uses empathy to consider how an individual would be impacted and how they would feel and suffer.[57] In order to utilize this lens, you have to view its impacts through the perspective of the individual being enhanced and whether it is morally justified to interrogate their brain. The expectation is that an enhanced service member will be superior on the battlefield, but how will it affect their lives at home, interactions with their family, and long-term health and happiness? Questioning how the implementation of this neurotechnology would be evaluated from an ethics of care lens would reinforce or dismiss the results of the utilitarian or Kantian lens. Military leaders are expected to care for their Soldiers, Sailors, Airmen, Marines, and Space Force Guardsmen. The public expects military leaders to prioritize the health and well-being of the service members that they are charged to lead. A good leader has the ability to empathize with

[55] Caron, "*Super Soldier*," 35
[56] Hinman, *Ethics*, 165.
[57] Hinman, *Ethics*, 290.

their subordinates while simultaneously giving orders that accomplish the mission. Invasive neurotechnology is counter to this role.

Invasive neurotechnology will completely change the way a person experiences life. In someone who is mentally or physically disabled, this could be a resounding success and encouraged if all other risks are mitigated. There is the potential to autonomously alter a person's mental state so that they don't experience stress, anxiety, and fear. This would lead to an improved mental state. This same stimulation combined with memory alteration has the potential to eliminate PTSD, which has destroyed the lives and numerous service members. However, for the able-bodied individual, there is too much risk to claim that enhancement is being done for their benefit.

Humanity Perspective

Humanity – Free Will – Trust – Equality

Humanity

What defines humanity? What does it mean to be human? Does it have something to do with the creation of life? In Mary Shelley's novel, Victor Frankenstein ponders this question when contemplating the creation of his monster, asking, "Whence…did the principle of life proceed?"[58] Although Victor was trying to inject life into something, is militarizing neurotechnology taking something away? Or are we creating a different type or variant of a human? Jangwan et al. used the term "*Homo sapiens technologicus*" to describe the current evolution of machine-human integration, stating that it is "a species that uses, fuses, and

[58] Mary Shelley, *The New Annotated Frankenstein*, ed. Leslie S. Klinger (New York: Liveright Publishing, 2017), 76.

integrates technology to enhance its own function."[59] Research scientists Manfred Clynes and Nathan Kline coined the term *cyborg*, an "exogenously extended organizational complex functioning as an integrated homeostatic system unconsciously,"[60] to describe a human enhanced with either mechanical features or altered beyond biological norms. Will this combination of human and machine create a 'cyborg warrior' that is "a weaponized brain-computer network powered by AI and neurocognitive augmentation?"[61] Using this definition, invasive technology can potentially create an army of cyborgs warriors or *homo sapiens technologicus*. Is that our goal as a society?

If not, how far can we push the limits to try to control human nature but keep those attributes that make people human? Through our quest for military dominance, will we lose sight of what it means to be human? One neurotechnology researcher was quoted saying that using deep brain stimulation (DBS) for human enhancement is "an ethical gray area" and will "really change the game of humanity."[62] Technologies such as these make you ponder the future of humanity from a biological perspective and ask the question of whether it's worth it to go down this path because it is difficult to correct the unintended consequences.

Free Will

Suppose that this technology is accepted and surgically installed in service members to help them cope with stress, anxiety, and fear. A platoon is sent on a mission to infiltrate a compound with orders to kill everyone in the building since they are all part of a terrorist

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[59] Jangwan, "Brain Augmentation," 2.
[60] Manfred E. Clynes and Nathan S. Kline, "Cyborgs and Space," *Astronautics*, September 1960. http://cyberneticzoo.com/wp-content/uploads/2012/01/cyborgs-Astronautics-sep1960.pdf.
[61] Katrine Nørgaard, and Michael Linden-Vørnle, "Cyborgs, Neuroweapons, and Network Command," *Scandinavian Journal of Military Studies* 4 (2021), 94, doi: https://doi.org/10.31374/sjms.86.
[62] Kostick-Quenet, "Researchers' Ethical Concerns," 5.

organization. The team breaches the compound and is overcome by emotions at the sight of women and children. The chip detects this abnormality and resets brain function to allow the mission to proceed. What would be the result of this action? Would the soldiers kill everyone in the building as ordered or engage only enemy combatants while protecting the innocent? Some neurotechnology researchers felt that the militarization of neurotechnology could interfere with a soldier's free will and their ability to properly evaluate and respond to their environment. [63] One specific concern was that the results could lead to "people [who], no matter what happens to them or what they're asked to do, they don't get traumatic harm from it, later adding that, Our conscience is important when we have people fighting, right? Otherwise we have atrocities."[64]

How can service members ensure that they are not forced to do something illegal that they have no control over? Caron is concerned "that capacity-increasing technologies…could end up directly or indirectly transforming soldiers into fully obedient killing machines who are unable to exercise any form of moral judgment about what they are ordered to do."[65] In this scenario, the soldier is no different from a lethal autonomous robot with no moral agency for its actions. If the person has no moral agency, then they can't determine right from wrong and, therefore, cannot be held accountable for their actions.

Service members are expected to follow orders, so it can be argued that their free will is limited when compared to civilians. However, there is an expectation that unethical or illegal orders are challenged regardless of pay grade and not followed. Article 92 of the Uniformed Code of Military Justice implicitly states this by holding a service member accountable who

[63] Kostick-Quenet, "Researchers' Ethical Concerns," 5.
[64] Kostick-Quenet, "Researchers' Ethical Concerns," 5.
[65] Caron, "*Super Soldier*," 45

"violates or fails to obey any lawful general order or regulation."[66] Neurotechnology, as described above, has the potential to remove the ability to challenge the unlawful orders of superiors, thereby eliminating a forcing mechanism in place to prevent anarchy and dishonor within the US military.

Trust

Trust is an integral component of military service. For the military establishment to be successful as an all-volunteer service, service members must trust that their leaders have their best interests in mind or that their sacrifices were for the greater good. Neurotechnology has the potential to interfere with their trust in the military establishment. One of the positives of this technology is the ability to cure PTSD through various means through stimulation of memory manipulation. One option was permanently erasing the memory as if the traumatic event never occurred. The soldier's life would no longer be negatively impacted by having to relive a traumatic event. This naturally leads to the possibility that a soldier's memory could be erased to hide unethical behavior or, even worse, war crimes. The legal aspect is not presented in this paper, but from the individual's perspective, their moral agency is removed, and they are being used as an object instead of a person. Worse yet, they would have no ability for recourse against those who used them to violate the law. Caron argues that a soldier's moral autonomy must be preserved, and any technology that deprives this ability should be rejected.[67]

Equality

There are two questions regarding equality using human enhancement neurotechnologies. The first question regards an unfair warfare advantage. What are the laws and ethics that govern

[66] United States Navy. Office of the Judge Advocate General, Index and Legislative History, Uniform Code of Military Justice, 1950.
[67] Caron, *"Super Soldier,"* 56

warfare between combatants with differing capabilities? Would the Just War Theory permit using super soldiers against a nation without the capability? Does it make a difference whether it is an advanced human on the battlefield versus a BCI-controlled platform? One of the issues with this soldier enhancement is that it creates an imbalance in the force, one who is "less vulnerable to being wounded or killed" and another group who is "more vulnerable to the deadly consequences of warfare."[68] Caron dismisses this issue by comparing the technological differences between nations throughout history and saying that this is nothing new.

The second question is about the equality of enhanced soldiers versus nonenhanced soldiers. How would the military differentiate treatment and recognition between the two? There would be an innate nature to prioritize the enhanced soldier due to their impact on the mission and money invested in the upgrades, which would be justifiable. What would be the impacts on the force? Would all soldiers want to be enhanced? Would they feel obligated to do so and disregard the potential long-term effects? Would traditional recruiting suffer even further, necessitating a soldier that could make the contributions of five?

Medical Views

Health – Safety – Accountability – Long-Term Care

The medical field has its own set of ethics that would have to allow invasive neurotechnology to be implanted in healthy service members. The Nuremberg Code was developed after World War 2, due to Hitler's attempt to create a superior race and, is still in

[68] Caron, *"Super Soldier,"* 9

effect today. The codes listed below would need to be satisfied in order for the medical field to allow this human enhancement:[69]

1. The voluntary consent of the human subject is absolutely essential.
4. The experiment should be so conducted as to avoid all unnecessary physical and mental suffering and injury.
6. The degree of risk to be taken should never exceed that determined by the humanitarian importance of the problem to be solved by the experiment.

Would medical ethics even allow invasive neurotechnology to be surgically implanted for able-bodied human enhancement? One researcher noted that "as a doctor, you wouldn't want to do surgery on someone that doesn't have a problem."[70] Another researcher elaborated, saying that "the risks of surgery are not insignificant. You could take someone who is essentially normal, and you could really wreck them or kill them."[71] Even if you could safely complete the surgery and alleviate the near-term risks, "long-term effects on the human body and cognitive or psychological functions cannot be wholly foreseen."[72]

Health

Medical neurotechnology researchers have raised concerns about their research being applied to able-bodied individuals and what the consequences would be. The "ability for adaptive Deep Brain Stimulation (aDBS) devices to read and write to the brain" and autonomously stimulate the brain enables the dual-use concern of modifying brain activity for human enhancement purposes in able-bodied individuals.[73] A survey of 23 adaptive aDBS researchers revealed that all of the researchers shared the concerns that this technology "should

[69] Evelyne Shuster, "Fifty Years Later: The Significance of the Nuremberg Code," *The New England Journal of Medicine* 337, no. 20 (1997): 1436, https://doi.org/10.1056/NEJM199711133372006.
[70] Kostick-Quenet, "Researchers' Ethical Concerns," 5.
[71] Kostick-Quenet, "Researchers' Ethical Concerns," 5.
[72] Emanuel, Cyborg Soldier 2050, 17.
[73] Kostick-Quenet, "Researchers' Ethical Concerns," 2.

not be considered for enhancement until researchers better understand brain target localization and functioning, of long-term effects on targeted and secondarily affected neural networks, and of how to further improve stimulation resolution."[74] It is unknown how the brain would respond to long-term use of the technology. Will the brain develop scar tissue that damages the brain? Will the stimulation become less effective over time as the brain adjusts?

The current research is for the implants to run on batteries, meaning that battery replacements must occur to prolong the system's life,[75] exacerbating exposure and risk to the soldier for complications or infection. Neuralink is developing the potential for wirelessly charging their device and using a lithium-ion battery similar to a cell phone. However, a rechargeable lithium-ion battery does not guarantee that batteries will never need to be replaced, which does not alleviate medical concerns.

Safety

What is the brain's response to having a foreign neural network installed over or inside of it providing external stimulation? Will the brain adapt to the stimulation and rely on it to function properly, or will it reject the foreign material? The answers to these questions determine some of the safety concerns with having a neural network or probes implanted in the brain long-term. The panel in the Cyborg Soldier 2050 alluded to these concerns saying that "researchers have not been able to determine whether the implantation of electrodes is reversible or to what extent affected neural networks adapt to the presence of an implant, thereby complicating removal."[76]

Neurotechnology researchers believe that enhancing an able-bodied individual would have too many safety risks. They specifically noted that there are "surgical risks and an

[74] Kostick-Quenet, "Researchers' Ethical Concerns," 7.
[75] Lozano, "Deep brain stimulation," 158.
[76] Emanuel, Cyborg Soldier 2050, 7.

imbalanced risk-benefit ratio when offering aDBS to healthy or 'normally' functioning individuals with potentially less to gain and more to lose compared to patients with a treatment-resistant disorder."[77]

Incorporating this technology into the battlefield is another concern. How stable are the probes in a combat environment with explosions, falls, and crashes? These events currently expose service members to concussions when the brain slams into the skull due to the force of impact. Will this cause the probes to move, stimulating a different brain region? What are those consequences? What permanent damage will that injury do to the soldier's brain?

Accountability

Accountability for the actions of the enhanced soldier is one of the more challenging issues for this technology. It resembles the current debate surrounding agency and using robotics and unmanned systems. Who is going to be held accountable for the actions of the technology? In the case of the prior two examples, it is clear that there isn't a defined answer for who would be responsible, especially if the system has autonomy and can act without a human in the loop. For the enhanced warfighter, it is more nuanced. If the neurotechnology is read-only and there is no ability for someone else to write to the brain and cause an action unintended by the host, then the host could be held accountable for all their actions. But what if the mission commander could write to the soldier's brain to execute an action without their right of denial? Who would be responsible for the soldier's actions? Will there be any way to prove that the mission commander was the one who wrote the code, or could they just erase the evidence? Emanuel et al. identified the possibility that an enhanced soldier could claim that the neurotechnology made them do it.[78]

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[77] Kostick-Quenet, "Researchers' Ethical Concerns," 6.
[78] Emanuel, Cyborg Soldier 2050, 17.

The legal standards for incorporating a neurotechnology enhancement would have to be developed before implementation to account for these possible scenarios.

Long-Term Care

Suppose soldier enhancement using invasive neurotechnology is a resounding success. Such soldiers outperform their predecessors on the battlefield, and side effects have been minimal and manageable. Now it's time to transition out of the field to a staff position where human enhancement is not needed. Does the implant remain in the soldier's head? If so, who is responsible for the long-term care, and what does treatment look like? What will happen if, rather than transitioning to a desk job, this soldier ends their obligated service and separates from the military? What is the long-term care provided to the soldier, and what type of monitoring will be required to ensure they are not a danger to society or do not become dangerous? Who is responsible for paying for this long-term care? The Department of Veterans Affairs is already understaffed and underfunded, so it is unlikely that they can be tasked with the care. It is also unlikely that they have enough neurosurgeons on staff with expertise in this area. The Department of Defense would have to consider what the long-term expenses are prior to considering human enhancement.

Researchers have expressed concerned about the amount of money it would cost for long-term maintenance and care for the implants.[79] Would insurance companies be willing to cover the cost of this for prior super soldiers, or would the military have to develop a medical corps responsible for the entire program to include post-service maintenance and oversight? Under the National Institute of Health BRAIN Initiative grant, researchers in the civilian sector have an

[79] Katrina A. Muñoz et al., "Researcher Perspectives on Ethical Considerations in Adaptive Deep Brain Stimulation Trials," *Frontiers in Human Neuroscience* 14 (2020): 7, doi:10.3389/fnhum.2020.578695.

obligation to develop a plan that accounts for this responsibility which the military would have to duplicate to be ethically acceptable.[80] Once the enhanced soldier leaves the military, without continuous evaluation and assessment, there is no way to know whether an issue with the device is occurring. What is the probability that the brain modifies its activity to account for long-term use of the stimulation and now relies on it for everyday function? This scenario would be similar to what happens when a long-term user of anti-depressants attempts to cease taking the medication. The brain has trouble coping with the transition.

Individual Perspective

Consent – Privacy – Neurosecurity – Confidentiality

The individual perspective is a critical component for neurotechnology legitimacy in DOD. The individual is providing access to their brain, and their thoughts, which can be viewed as the ultimate form of vulnerability. Beyond access, the soldiers trust the government to provide neurosecurity that prevents unauthorized access to their brain or the data it produces. Trust will be critical to the success of military human enhancement. Many people will be skeptical that there are ulterior motives for implanting a device in someone's brain. Even fellow service members may be suspicious when an enhanced soldier joins their team. Researchers and analysts must take an approach from the individual's perspective when determining the viability of introducing invasive neurotechnology into warfare and build trust to ensure it is successful.

Consent

Individual consent must be required in all aspects of invasive neurotechnology, from research to implementation. Some researchers argued that "if a warfighter is allowed no

[80] Demetrio Sierra-Mercado et al., Device Removal Following Brain Implant Research, 759.

autonomous freedom to accept or decline an enhancement intervention, and the intervention in question is as invasive as remote brain control, then the ethical implications are immense."[81] Consent is a critical component for human trials in the medical field and needs to be adopted by the military. Some may argue that this is obvious; however, there will be increased pressure on service members to undergo the enhancement. Unenhanced soldiers may perceive themselves as inferior, and the only way to prove their worth is to undergo enhancement. This pressure could be created by the organization or the individual, but regardless, unconditional consent must be required. An effective screening method to determine legitimate consent should be implemented. This technology impacts every aspect of the soldier's life so consideration should be given to dependents and whether they should also have to provide consent for their loved ones to be enhanced.

Privacy

Privacy protection is critical to building trust between the service member and the government. Neurotechnology is accessing brain activity and the private thoughts of people. Who owns the rights to the data, and how is it stored and utilized? This is a common question regarding service members' medical records and biometric data. It would be exacerbated in the enhanced soldier. The data privacy question must be extended to anyone interacting with the service member. If the brain functionality and, therefore, the thoughts of the enhanced service members are always being recorded for analysis, then the privacy of everyone who interacts with the service member is now being violated. One study discussed a coffee shop scenario where many conversations occur with the expectation that no one is recording them. Will there be a requirement to turn on and off the enhancement based on whether the person is on or off duty? Is

[81] Michael N. Tennison and Jonathan D. Moreno, "Neuroscience, Ethics, and National Security: The State of the Art," *PLoS Biology* 10, no. 3 (2012): 2, https://doi.org/10.1371/journal.pbio.1001289.

this even feasible? Munoz et al. raised numerous ethical questions about data privacy and security and how that would balance with consent and truly understanding how the device works and how the data is utilized.[82]

Neurosecurity

Neurosecurity can be defined "as the protection of the confidentiality, integrity, and availability of neural devices from malicious parties with the goal of preserving the safety of a person's neural mechanisms, neural computation, and free will."[83] Impenetrable cyber security is required to ensure that the device cannot be hacked. Defeating the enemy soldiers on the battlefield is normally the center of gravity for the operation and becomes the primary objective. Imagine if it was possible to defeat those soldiers without firing a weapon. Enhanced soldiers become a primary target for a cyber-attack if they have an electronic device in their brains. Two potential neurodata threat vectors are manipulating that data to create an adverse effect on an individual or utilizing an individual's brain data to develop a precision effect.[84] State and non-state actors will be aggressive in their attempts to disrupt a service member's ability to function on the battlefield. It has been shown that the capability exists to hack into BCI devices and extract information about the users,[85] so it is plausible that an adversary could disable the device once it's been infiltrated. BCIs rely on data ingestion to maximize their capabilities which opens the potential for data manipulation that can affect the operator's cognition, emotion, and

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[82] Munoz, Researcher Perspectives, 3-7.

[83] Tamara Denning, Yoky Matsuoka, and Tadayoshi Kohno, "Neurosecurity: security and privacy for neural devices," *Neurosurgical Focus* 27, no. 1 (2009): 1, https://doi.org/10.3171/2009.4.FOCUS0985.

[84] Joseph DeFranco, Diane DiEuliis, and James Giordano, "Redefining Neuroweapons: Emerging Capabilities in Neuroscience and Neurotechnology," *Prism (Washington, D.C.)* 8, no. 3 (2019): 56.

[85] Ienca, Jotterand, and Elger, "From Healthcare to Warfare and Reverse," 270.

behavior.[86] What are the consequences that these security risks create? If an adversary is able to hack into the device that controls a soldier's emotional response, they can essentially disable the soldier's ability to perform their mission. Is it possible to overload the device? Would that lead to immediate death? Researchers have expressed concern that someone could possibly hack the device to "control patients" and potentially "send the person into a manic state."[87] Another concern identified by a RAND Corporation study was the potential for an electronic warfare attack that could disable the enhanced soldier rendering them incapable of functioning.[88]

Confidentiality

Enhanced soldier confidentiality is a difficult debate. What would be the expectations for confidentiality regarding who is enhanced? Is there an ethical responsibility to other military service members and the public to know who has an enhancement and what that enhancement consists of? The desire to do the right thing for the public must be weighed against the national security implications of publicizing what service members are enhanced. An enemy nation or a non-state actor would consider the identity of enhanced service members as an intelligence gold mine. This is why the identities of special operations forces and Central Intelligence Agency operatives are not publicized. However, confidentiality might not protect the service member. Ienca and Haselager referenced research that accessed a person's BCI to extract data ranging from their personal banking information to the faces of people that they knew.[89]

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[86] DeFranco, "Redefining Neuroweapons, 57.
[87] Munoz, Researcher Perspectives, 3.
[88] Anika Binnendijk, Timothy Marler, and Elizabeth M. Bartels, Brain-Computer Interfaces: U.S. Military Applications and Implications, (RAND Corporation, 2020), https://www.rand.org/t/RR2996.
[89] Marcello Ienca and Pim Haselager, "Hacking the Brain: Brain-Computer Interfacing Technology and the Ethics of Neurosecurity," *Ethics and Information Technology* 18, no. 2 (2016): 120, https://doi.org/10.1007/s10676-016-9398-9.

Social Implications

Effect on Society – Reintegration

Effect of Society

How will the implementation of this technology be accepted by society, or will it? As discussed earlier, the US is an all-volunteer service, so society's acceptance of the technology is critical to maintaining a stable stream of recruits. A thoughtful public affairs approach is important to ensure that any public concerns are addressed. A recent study was conducted to determine the acceptance of neurotechnology breakthroughs with the goal of human enhancement. The study, "U.S. Public Wary of Biomedical Technologies to 'Enhance' Human Abilities," determined that 69% of the respondents were concerned about implementing brain chips and that concern was more prevalent than excitement in the responses.[90]

There are international societal challenges that need to be considered as well. Are allies that do not have an enhanced soldier program going to want to integrate with an enhanced team of operatives? Will they trust the enhanced team, or will this need to be a specialized unit that always works alone? If the latter is considered, then it minimizes the effectiveness that enhanced soldiers can have on the battlefield and reduces the benefits associated with the risk.

Reintegration

Neurotechnology, which is developed by the military in the name of national security, has the potential to bleed over into society, especially as the service member transitions from the military back into civilian life. If the technology is removed, will the service member cognitively return back to a normal state, or will it be reduced due to an overreliance on neurotechnology? If

[90] Emanuel, Cyborg Soldier 2050, 10.

it is reduced, then the person will end up with a disability that could require that same neurotechnology to remedy. The ethical consideration for these concerns is that we won't know the answers before implementing the technology.

Chapter 3 – Impacts and Assessment

Reasons Why the Military Could Pursue

Considering the argument above, one may ask why the military would pursue this type of technology. There are three potential answers. The DOD has an obligation to explore all technologies that could protect warfighters before, during, and after a war. The American public sends their loved ones to fight for their nation with an expectation that the government does everything in its power to protect them while they fight. Second, it provides an asymmetric advantage on the battlefield or, if already developed by adversaries, levels the playing field. Militaries throughout history have sought a technological advantage that would help ensure that their political objectives were achieved. Third, there is an innate fear within governments that they may lose the arms race with adversaries for technological development. There are examples of this between the Allies and Axis powers during World War II and between the US and the Soviet Union during the Cold War.

The advancement of technology in the military has always been representative of the power of that nation's military. A superpower had the military and economic industry to develop weapons superior to the enemy. Some of these technologies were developed in academia and industry and then adopted by the military for their specific purpose. Others were developed strictly for the military. Shields protected the warriors of Greece. Armor provided protection to Knights. Gunpowder allowed troops to gain separation from the enemy. Word War II saw the introduction of some of the most influential weapons of destruction. Mechanized vehicles replaced horseback, allowing units to overwhelm an enemy's defenses while remaining mostly protected from damage. Fighter aircraft and long-range bombers changed how strategists targeted industrial complexes that produced critical requirements for the enemy forces. Aircraft

carriers created mobile airfields that could project power onto land from the protection of the seas. The atomic bombs dropped on Hiroshima and Nagasaki exemplified the horrific nature of technological destruction and started an arms race for nuclear deterrence throughout the Cold War. Unmanned aerial vehicles designed primarily for Intelligence, Surveillance, and Reconnaissance have become weaponized and demonstrated the ability to strike a target with the operator located on the other side of the world. Today, the modernization of nuclear weapons and the development and implementation of unmanned aerial, surface, and subsurface systems are at the forefront of military planning efforts.

However, having a technological advantage hasn't prevented continued technological development from occurring in the United States and other countries worldwide. High-energy laser weapons and hypersonic missiles are in testing and development to implement into the military arsenal. There is a second nuclear race to modernize the nuclear capabilities in the United States, Russia, and China. Biotechnology and neurotechnology are in research and development as the future of technological innovation. Although both technologies are mostly being developed in academia and industry, the military has expressed interest in how they can provide an asymmetric advantage on the battlefield.

Means to What End

Although it may be obvious, it is important to note that neurotechnology differs greatly from the advancement of military technologies described above. It is different when the technology is artificially enhancing the warfighter themselves. Neurotechnology can alter the human nature of individuals and change the course of what it means to be human. The biggest issue is that it is unlikely that researchers can identify all of the possible second and third-order

consequences of invasive neurotechnology prior to implementation. This doesn't include unintended consequences that are likely to develop.

Military operations are guided by a ways, means, and ends approach. The ways are how an objective is going to be achieved, the means are the resources that are used, and the ends are what is being accomplished. Neurotechnology can be considered the means in this example. But what are the ends? What are we trying to achieve with invasive neurotechnology? The means and ends allow ethicists to determine whether technology is morally good or bad. There are a few plausible ends: 1) give the warfighter every possible advantage to survive, 2) reduce the long-term impacts of war fighting on the service member, 3) gain an asymmetric advantage over the adversary, or 4) regain technological parity with near-peer adversaries.

Cost/Benefit Analysis

Numerous potential benefits have been discussed throughout this paper, but are they worth the cost and risk associated with them? A RAND Corporation analysis on BCIs concluded that DOD needs to take action to reduce the ethical and legal risks to make the benefits worth the costs. Their results highlighted that DOD needs to determine relevance to operations and associated risks to those operations, identify trust issues that could arise incorporating enhanced soldiers into combat teams, collaborate with private sectors to identify breakthroughs and get ahead of ethical and legal issues by codifying governing norms and laws.[91]

Is this type of technology worth it from a practical standpoint? The only way it can be justified is if we know exactly how the cognitive process is enhanced, along with the risks and

[91] Binnendijk, Brain-Computer Interfaces.

costs of the enhancement.[92] Devices such as deep brain stimulation (DBS) and adaptive deep brain stimulation (aDBS) would require "large capital costs and necessitates a large, expert multidisciplinary team to provide programmes for patients and troubleshooting issues."[93] The DOD already receives the largest percentage of the federal budget,[94] and the amount is a topic of contention every year in Congress. Although the total cost and long-term care are unknown at this time, it is not difficult to conclude that without the removal of other significant military capabilities, the DOD budget would not be able to support neurotechnology integration.

[92] Jangwan, "Brain Augmentation," 2.
[93] Lozano, "Deep brain stimulation," 158.
[94] Molly Parrish, "Navigating the Billions: A Beginner's Guide to the Defense Budget," Center for a New American Security, Last Modified February 11, 2020, https://www.cnas.org/publications/commentary/navigating-the-billions.

Recommendations and Conclusion

The Ethical, Legal, and Social Implication (ELSI) panels in neurotechnology research establishments need to have the ultimate authority on whether research should continue or end before unintended consequences occur. Currently, the ELSI panels only provide a recommendation to leadership on whether research should proceed and may not be enough when dealing with invasive neurotechnology. The ELSI team needs to have the moral agency and sole discretion to pull the trigger and destroy a creation that can cause harm to society, akin to Dr. Susan Calvin terminating a robot that's capabilities exceeded its safety parameters and norms in Isaac Asimov's "Robot Dreams".[95]

The US must be prepared to accept that China adopts BCI neurotechnology first due to their "government structure, sociocultural norms, and greater alignment of brain project goals with military goals."[96] The government cannot overreact to China's progress and force invasive neurotechnology's use despite ELSI recommendations. Although there are national security issues with establishing neurotechnology norms and privacy concerns if China's technology becomes used globally,[97] it cannot come at the expense of American values. However, the US government can prepare for this possibility, by helping coordinate the DOD, academia, and private industry neurotechnology research and development goals to maximize breakthroughs and avoid pitfalls.

There is an opportunity for future studies of this paper through the legal lens and how invasive soldier enhancement would be viewed from the Law of Armed Conflict and Just War Theory perspective. Is there a proportionality issue using super soldiers on the battlefield? Legal

[95] Isaac Asimov, "Robot Dreams," Robot Dreams, New York: Penguin Group, 1986, 28.
[96] Kosal and Putney, "Neurotechnology and International Security," 17.
[97] Kosal and Putney, "Neurotechnology and International Security," 17.

frameworks are likely to be outpaced by the speed at which these new technologies are developed, so it is critical that legal analysts start working as early as feasible.[98]

As neurotechnology develops, it is likely to quickly integrate into military capabilities. The potential to create an asymmetric advantage in warfare while protecting soldiers' lives is too great to ignore. However, the level of invasiveness increases the risks. The integration of invasive neurotechnology will impact humanity and change the way a soldier experiences life. The concern is that those impacts won't be known until after the technology is integrated. This is why an ethical framework needs to be established to identify and discuss ethical, medical, legal, and societal concerns while giving weight to the individual's perspective. The answer cannot be to keep up with China's development or to incorporate the technology first to establish international norms and laws. Those are important but not at the expense of the service member's livelihood.

[98] Emanuel, Cyborg Soldier 2050, 12.

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