NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

NEUROWAR IS HERE!

by

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December 2021

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REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** December 2021	**3. REPORT TYPE AND DATES COVERED** Master's thesis

4. TITLE AND SUBTITLE NEUROWAR IS HERE!	**5. FUNDING NUMBERS**
6. AUTHOR(S) Joshua D. Gramm and Brian A. Branagan	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A	**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.	**12b. DISTRIBUTION CODE** A

13. ABSTRACT (maximum 200 words)

Mysterious attacks on the human brain have begun plaguing U.S. diplomats and officials with increasing frequency, ranging from overseas diplomatic outposts to right here in the United States. Known in the media as Havana Syndrome, these attacks appear to be signaling a new form of warfare—one that is focused on enhancing, targeting, and weaponizing the human brain—neurowarfare. Indeed, the human brain is at the center of a biotechnological revolution currently underway. At the same time, great power competition has returned to the forefront of international relations, as China and Russia seek to contest America's global leadership. In an increasingly globalized and interconnected world, this contest is ultimately a battle of ideas and influence, with more value placed on information and non-lethal means to manipulate and control both adversaries and domestic populations alike. The battle for influence begins and ends in the human mind, where reality is perceived. The implications of these developments point to both a new form and domain of warfare centering on the human brain. By highlighting recent attacks targeting the brain and revealing research from the United States and its two main competitors—China and Russia—this thesis seeks to argue that neurowar is not just coming, but rather is already here and is likely to fundamentally alter conflict and warfare.

14. SUBJECT TERMS neurowar, neurowarfare, neuro S&T, GPC, Great Power Competition	**15. NUMBER OF PAGES** 145
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UU

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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NEUROWAR IS HERE!

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MASTER OF SCIENCE IN DEFENSE ANALYSIS
(IRREGULAR WARFARE)

from the

NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

Mysterious attacks on the human brain have begun plaguing U.S. diplomats and officials with increasing frequency, ranging from overseas diplomatic outposts to right here in the United States. Known in the media as Havana Syndrome, these attacks appear to be signaling a new form of warfare—one that is focused on enhancing, targeting, and weaponizing the human brain—neurowarfare. Indeed, the human brain is at the center of a biotechnological revolution currently underway. At the same time, great power competition has returned to the forefront of international relations, as China and Russia seek to contest America's global leadership. In an increasingly globalized and interconnected world, this contest is ultimately a battle of ideas and influence, with more value placed on information and non-lethal means to manipulate and control both adversaries and domestic populations alike. The battle for influence begins and ends in the human mind, where reality is perceived. The implications of these developments point to both a new form and domain of warfare centering on the human brain. By highlighting recent attacks targeting the brain and revealing research from the United States and its two main competitors—China and Russia—this thesis seeks to argue that neurowar is not just coming, but rather is already here and is likely to fundamentally alter conflict and warfare.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADIZ	area defense identification zone
AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Laboratory
AHI	anomalous health incident
AI	artificial intelligence
ARL	Army Research Laboratory
BCI	brain computer interface
BRAIN	Brain Research through Advancing Innovative Neurotechnologies
Brain/MINDS	Japanese-based Brain Mapping by Integrated Neurotechnologies for Disease Studies
BRI	Belt Road Initiative
BTO	Biological Technical Office
BTWC	Biological and Toxin Weapons Convention
BWC	Biological Weapons Convention
CCP	Chinese Communist Party
CIA	Central Intelligence Agency
CMC	Chinese Central Military Commission
CMPN	Center for Military Psychiatry and Neuroscience
COE	Center of Excellence
COTS	commercial-off-the-shelf
CRADA	Cooperative Research and Development Agreement
CT2WS	Cognitive Technology Threat Warning System
ctVNS	cervical transcutaneous vagal nerve stimulation
CWC	Chemical Weapons Convention
DARPA	Defense Advanced Research Projects Agency
DE	directed energy
DepSecDef	Deputy Secretary of Defense
DEW	directed energy weapon
DHA	Defense Health Agency
DIME	Diplomatic Information Military Economic

DIUx	Defense Innovation Unit Experimental
DOD	Department of Defense
DOS	Department of State
EEG	electroencephalography
EEMC	Europe and Eurasia Mission Center
ELSI	ethical, legal, social implications
EMP	electromagnetic pulse
EU	European Union
FDA	Food and Drug Administration
GDP	gross domestic product
GPC	Great Power Competition
GRU	Russian Main Military Intelligence Directorate
HBP	Human Brain Project
HEO	hyper-enabled operator
HGP	Human Genome Project
HMI	human machine interface
HPM	high-powered microwaves
HPW	Human Performance Wing
IARPA	Intelligence Advanced Research Projects Agency
IC	Intelligence Community
IOP	instruments of power
IW	information warfare
JIFCO	Joint Intermediate Force Capabilities Office
JSOU	Joint Special Operations University
KGB	Former Russian Intelligence Agency
KSA	knowledge, skills, and abilities
LAC	Line of Actual Control
MCF	Military-Civil Fusion
MEG	magnetoencephalography
MHS	Military Health System
MISO	military information support operations
NAS	National Academy of Sciences

NCW	new concept weapons
NDS	National Defense Strategy
Neuro S&T	neuroscience and neurotechnology
NLW	non-lethal weapons
NLWP	Non-Lethal Weapons Program
NIH	National Institute of Health
NIS	neural interface systems
NSA	National Security Agency
NSC	National Security Council
NSF	National Science Foundation
NSS	National Security Strategy
ODNI	Office of the Director of National Intelligence
ONR	Office of Naval Research
PLA	People's Liberation Army
POTUS	President of the United States
POW	prisoner of war
PPP	purchasing power parity
PSYOP	psychological operation
PTSD	post-traumatic stress disorder
R&D	research and development
RF	radio frequency
RMA	revolution in military affairs
S&T	science and technology
SAIS	School of Advanced International Studies
SCS	Social Credit System
SecDef	Secretary of Defense
SOF AT&L	Special Operations Force Acquisition, Technology, and Logistics
SS-ADT	Solid State Active Denial Technology
TBI	traumatic brain injury
tDCS	transcranial direct current stimulation
TMS	transcranial magnetic stimulation
U.S.	United States

UBI	unconventionally acquired brain injury
USA	United States Army
USAF	United States Air Force
USAID	United States Agency for International Development
USMC	United States Marine Corp
USN	United States Navy
USSOCOM	United States Special Operations Command
USSOUTHCOM	United States Southern Command

EXECUTIVE SUMMARY

Mysterious attacks on the human brain have begun plaguing U.S. diplomats and officials with increasing frequency, not only overseas at diplomatic outposts but also in the United States. Known in the media as Havana Syndrome, these attacks appear to be signaling a new form of warfare—one that is focused on enhancing, targeting, and weaponizing the human brain: neurowarfare. This thesis explores the human brain as the next battlefield, leading to a new domain, and likely the last domain of warfare as the brain serves as the foundation of all other domains. The implications are likely to alter the nature of conflict and many of the assumptions that warfare is built upon.

This paper uses unclassified, publicly available information to both analyze the events surrounding the Havana Syndrome, and to understand this apparent new form of warfare called *neurowarfare* within a greater strategic and neuroscientific context. The authors argue that neurowar is not just coming; it is already here, and it plays a crucial part in the context of Great Power Competition (GPC). Indeed, GPC is ultimately a contest for access and influence among states throughout the globe, and neurowarfare is another tool akin to a gray zone activity that can be used to increase a state's influence in a highly competitive security environment.

Not only is the U.S. government, and specifically the national security community, investing heavily in neuroscience and neurotechnology—neuro S&T—but so is its largest competitors: China and Russia. Both states either have or are actively developing neuroweapons, as well as the requisite concepts of operations on how best to employ them. It is also likely that one or both states has already employed neuroweapons. China and Russia clearly believe in the importance of this new technology and see the military and strategic potential it offers.

Furthermore, from a strategic standpoint, the instruments, tools, and impacts necessary for neurowar are increasingly similar to the same tools needed for political power, thus increasing the likelihood of their continued development, employment, and implementation. As the cost of both preparing for and waging conventional war increases

in an era of globalization defined by economic, social, and cultural interdependencies, the primary method of aggression and destabilization has shifted from pursuing physical destruction and violence to influencing and controlling large populations.

In light of these developments, the authors recommend the U.S. national security community should increase awareness of neurowarfare and its impending dangers and impacts on its personnel. The United States also needs to decide whether it should pursue neuro S&T that could be used to degrade an adversary—technologies Russia and China are developing in earnest. The Intelligence Community, specifically, has a key role in monitoring the development of neurotechnologies and the potential development and employment of neuroweapons. Finally, the United States must determine how to respond to neuroweapon attacks, especially as they increase in frequency.

ACKNOWLEDGMENTS

We would like to thank Dr. Shannon Houck for not only serving as our thesis advisor but also for recommending the topic of neurowarfare to us. She allowed us the freedom to pursue this topic in our own way. We enjoyed our many discussions on this subject and are grateful for all of her advice, feedback, and mentorship throughout this process. We would also like to thank Dr. Kalev Sepp and Dr. John Arquilla for taking time out of their busy schedules to provide thoughtful feedback, suggestions, and recommendations on how to improve our thesis. Finally, we would like to thank the faculty of the Defense Analysis Department who taught, influenced, and shaped our thinking over the past 18 months. Any remaining errors and omissions are the sole responsibility of the authors.

Most importantly, we would like to thank our families for their love, support, and understanding while we spent time away from them researching, writing, and editing. It is only through their encouragement that we were able to complete this thesis.

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I. INTRODUCTION AND LITERATURE REVIEW

> We still don't know for sure, but I am absolutely determined — and I've spent a great deal of time and energy on this in the four months I've been CIA director — to get to the bottom of the question of what and who caused this.
>
> —William Burns,
> Central Intelligence Agency Director, 22 July 2021[1]

In late 2016 in Havana, Cuba, a collection of U.S. diplomats, intelligence officials, and military personnel began experiencing mysterious and often debilitating neurophysiological and cognitive symptoms reminiscent of a traumatic brain injury, but without any precipitating trauma. Symptoms included headaches, dizziness, fatigue, nausea, anxiety, vertigo, memory loss, and other cognitive difficulties. All reported feeling waves of pressure in their heads, ranging from a dull discomfort to immediately overwhelming. Many stated that simply moving from one room to another alleviated symptoms.[2]

These incidents were not limited to government officials; even children and pets displayed peculiar and troubling behaviors. However, many of the individuals affected did not immediately discuss their private health concerns with bosses and co-workers as they struggled to understand what was happening. Eventually, they independently sought medical care and treatment, and rumors began to circulate about the cause of these symptoms.

Only in the past few years has this information begun to surface in the public domain, and there have been no shortage of theories surrounding the origin of this mystery,

[1] Mary Louise Kelly, "Transcript: NPR's Full Conversation With CIA Director William Burns," *NPR*, July 22, 2021, sec. National Security, https://www.npr.org/2021/07/22/1017900583/transcript-nprs-full-conversation-with-cia-director-william-burns.

[2] Adam Entous and Jon Lee Anderson, "The Mystery of the Havana Syndrome," *The New Yorker*, November 9, 2018, https://www.newyorker.com/magazine/2018/11/19/the-mystery-of-the-havana-syndrome.

including sonic weapons, microwaves, insecticides, crickets, mass hysteria, and everyday aches and pains, to name a few.[3] Some of these theories corroborate what victims report, whereas others claim these individuals are not "victims" at all but rather suffer from "mass hysteria." Indeed, even a book called *Havana Syndrome: Mass Psychogenic Illness and the Real Story Behind the Embassy Mystery and Hysteria* was written to explain away this incident. However, a Department of State (DOS)–funded team of neuroscience experts suggest these incidents are the result of intentional attacks. For example, Dr. James Giordano, a neuropathologist and one of the DOS-appointed scientists who investigated the Cuba cases, stated in his 2018 United States Special Operations Command (USSOCOM)/J5 Donovan Group SOFWERX brief: "this is intentional, this is directed, this seems to be a beta test of some type of a viable neuroweapon."[4] An extensive 2020 report from the National Academies of Sciences (NAS) suggested the most plausible cause for this type of incident is some form of directed energy (DE).[5]

Years after the reports from Havana diplomats, there has been increased concern that these symptoms were caused by a type of neuroweapon—specifically, a directed energy weapon (DEW)—aimed at impairing the target's brain. In addition to a thorough analysis on the plausibility of a DEW, the NAS report documents the medical effects experienced by the Havana Syndrome patients. The USSOCOM has defined these cluster of symptoms without a traumatic incident or known etiology as "unconventionally acquired brain injury" (UBI),[6] and more recently, the Secretary of Defense's (SecDef) September

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[3] Robert Bartholomew, "An Open Letter to the Diplomats With 'Havana Syndrome,'" *Psychology Today*, November 2, 2019, https://www.psychologytoday.com/us/blog/its-catching/201911/open-letter-the-diplomats-havana-syndrome.

[4] "J5 Donovan Group Radical Speaker Series: Neuroweapons," SOFWERX, August 21, 2018, https://www.sofwerx.org/neuroweapons/.

[5] National Academies of Sciences, Engineering, and Medicine. 2020, *An Assessment of Illness in U.S. Government Employees and Their Families at Overseas Embassies* (Washington, DC: The National Academies Press, 2020), x, https://doi.org/10.17226/25889.

[6] Adam T. Biggs et al., "Unconventionally Acquired Brain Injury: Guidance and Instruction About an Emerging Challenge to Warfighter Brain Health," *Journal of Special Operations Medicine* 21, no. 2 (2021): 43–48.

2021 memo termed them "Anomalous Health Incidents" (AHI).[7] The most common symptoms of AHIs are "the sudden onset of a perceived loud sound, sometimes described as screeching, chirping, clicking, or piercing, a sensation of intense pressure or vibration in the head, and pain in the ear or more diffusely in the head."[8] Patients had acute symptoms of dizziness, fatigue, impaired balance, headache, and impaired concentration, but many symptoms became chronic years after initial onset.[9] The directional and location-specific details in the patients' histories are unusual and "unlike any disorder reported in the neurological or general medical literature," providing the basis for increased suspicions of DEWs.[10] These incidents lead to many questions about their origin and how to characterize these types of attacks.

A. THE EMERGENCE OF NEUROWEAPONS

The attacks in Cuba are one of the first-known uses of a neuroweapon. Neuroweapons are a broad category encompassing several different methods defined as "weapons that specifically target the brain or the central nervous system in order to affect the targeted person's mental state, mental capacity and ultimately the person's behavior in a specific and predictable way."[11] Of course, this is an alarming experience for targets. To use a metaphor, not only are fully-functioning individual chess pieces being surgically and systematically removed from the chessboard at great detriment to their long-term health, but operational-level neuro-technological tactics are having strategic effects. First, these individuals have decades of institutional knowledge and operational experience that cannot be quickly or easily replaced, causing instability and discontinuity in their organizations. There is both a finite number of experts willing and able to replace those impacted.

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[7] Lloyd J. III Austin, "Anomalous Health Incidents" (Official Memorandum, Washington, DC: Department of Defense, 2021), https://media.defense.gov/2021/Sep/15/2002855031/-1/-1/1/Anomalous-Health-Incidents.PDF.

[8] National Academies of Sciences, Engineering, and Medicine. 2020, *An Assessment of Illness in U.S. Government Employees and Their Families at Overseas Embassies*, 11.

[9] National Academies of Sciences, Engineering, and Medicine. 2020, 11.

[10] National Academies of Sciences, Engineering, and Medicine. 2020, 11.

[11] Armin Krishnan, *Military Neuroscience and the Coming Age of Neurowarfare*, 1st edition, Emerging Technologies, Ethics and International Affairs (London New York: Routledge, Taylor & Francis Group, 2018), 11.

Furthermore, some families have been impacted, which can serve as a deterrent for anyone not wanting to replace a targeted individual in their job by putting either themselves or their families at risk. Second, this is also impacting diplomatic relations. When the attacks in Cuba occurred, it was at a critical juncture in the bilateral relationship between Cuba and the United States. By late 2017, the DOS recalled a majority of their personnel stationed in-country in order to protect their people, thus significantly cooling the previously warming ties between the two states.[12] What is going on, who caused this, and why is this happening?

The incidents in Cuba, dubbed the "Havana Syndrome," are not isolated events. A similar incident occurred in Guangzhou, China, in 2017,[13] and as many as 200 Americans have developed UBI/AHI symptoms after serving in at least 16 different countries, including the United States.[14] Every day appears to bring more information about the frequency and locations of this type of incident, including disrupting Vice President Kamala Harris' recent trip to Vietnam, an alarming fact considering the highest levels of security provided.[15] "There are probably a couple of hundred incidents across the U.S. government and across the globe," current CIA Director William Burns recently stated.[16] For obvious reasons, the government has kept most of this information close-hold, refraining from speculation presumably as the intelligence and justice communities investigate, analyze, and draw inferences. As the quote at the beginning of this chapter

[12] Sarah Marsh and Marc Frank, "Drastic Staff Cuts at U.S. Embassy in Cuba Now Permanent," *Reuters*, March 2, 2018, sec. Emerging Markets, https://www.reuters.com/article/us-cuba-usa-idUSKCN1GE2HX.

[13] Josh Lederman, "Evacuated After 'Health Attacks' in Cuba and China, Diplomats Face New Ordeals in U.S.," *NBC News*, October 29, 2018, https://www.nbcnews.com/news/investigations/evacuated-after-health-attacks-cuba-china-diplomats-face-new-ordeals-n920241.

[14] Ken Dilanian, Josh Lederman, and Courtney Kube, "As Many as 200 Americans Have Now Reported Possible Symptoms of 'Havana Syndrome,' Officials Say," *NBC News*, July 20, 2021, https://www.nbcnews.com/politics/national-security/many-200-americans-have-now-reported-possible-symptoms-havana-syndrome-n1274385.

[15] Jasmine Wright et al., "Possible Havana Syndrome Incident Delayed Harris Flight to Vietnam," *CNN*, August 25, 2021, https://www.cnn.com/2021/08/24/politics/kamala-harris-vietnam/index.html.

[16] Kelly, "Transcript."

shows, Director Burns has publicly stated he does not know who or what caused this, but it is one of his highest priorities.[17]

B. THESIS SCOPE AND PURPOSE

This paper uses unclassified, publicly available information to both explore the events surrounding the Havana Syndrome, and to understand this apparent new form of warfare called *neurowarfare* within a greater strategic and neuroscientific context. The authors argue that not only is neurowar coming, it is already here now, and it will be a crucial part of this era of GPC. Our research indicates that not only is the U.S. government, and specifically the national security community, investing heavily in neuroscience and neurotechnology—neuro S&T—but also its largest competitors, China and Russia, also believe it to be the future of warfare.

This paper is purposely written at the unclassified level in order to inform and bring awareness to military and government officials who may not have access to classified information on the matter but are nonetheless operating in this environment, both as potential targets, but more importantly as stakeholders. The authors of this work, although associated with the U.S. Department of Defense (DOD), do not hold nor cannot access any secret knowledge to inform conclusions or opinions. *All* information contained in this thesis is sourced from the public domain.

To date, neuroweapon attacks against American officials, although incredibly damaging for individuals, have been conducted in a non-lethal capacity. Due to the uncertainty surrounding causes and issues of attribution, these attacks have not elevated to a level of aggression that has impelled an international response. However, the fire has been lit. The development and employment of neuroweapons is leading to an era of *neurowarfare*, which the authors contend is not just a new form of warfare, but is a new *domain* of warfare.[18] Perhaps it is the last and most important domain because it is the centerpiece of human cognition and serves as the foundation for all other domains of

[17] Kelly.

[18] Chloe Diggins and Clint Arizmendi, "Hacking the Human Brain: The Next Domain of Warfare," *Wired*, December 11, 2012, https://www.wired.com/2012/12/the-next-warfare-domain-is-your-brain/.

warfare. Neurowarfare has the capacity to fundamentally alter conflict for the rest of human history. The technology, organizational capacity, potential, implications, and resultant stakes are significant. The evidence we present in this thesis suggests that the first country to develop, refine, and implement this form of warfare will likely have the capacity to dominate the world stage. Similar to other domains, the country that not only develops the technology, but also integrates the strategy, organizational structure, doctrine, and information systems associated with neurowarfare in a comprehensive design may become the most powerful country in the history of the planet due to the centrality of the human brain.[19]

C. EXISTING SCHOLARSHIP ON NEUROWARFARE

This thesis is certainly not the first scholarly effort to examine neuroweapons, neurowarfare, and its implications. However, it is a relatively niche and new area of interest that requires in-depth study to differentiate truth from fiction. While there are many open-source references to government efforts to militarize neuro S&T research and development (R&D) for explicit national security purposes, they lack a larger context to understand what neurowarfare is, how it can be classified, how it is currently unfolding, and how U.S. adversaries view neurowarfare. Major efforts to document and publicize the impending neurowarfare environment in the national security space has only recently started, with efforts likely hampered due to classification issues. Admittedly, all efforts will be incomplete due to the same classification issues. However, the most recent scholarly work occurred in 2017, before the rise of Havana Syndrome and employment of neuroweapons, leaving a clear gap and need to update the literature. This section will briefly cover three of the leading figures and books in this arena.

In 2006, Dr. Jonathan Moreno, a bioethics professor from the University of Pennsylvania, wrote *Mind Wars: Brain Research and National Defense* as the first academic endeavor to catalogue and explore military efforts to harness civilian research in

[19] John Arquilla and David Ronfeldt, "Cyberwar Is Coming!," *Comparative Strategy* 12, no. 2 (April 1, 1993): 142, https://doi.org/10.1080/01495939308402915.

neuroscience.[20] This well-written and well-researched investigative book stretches the imagination into what's possible, leaving a sense of awe and fear. He presents the science, highlights potential military and national security applications, and sounds the alarm on how few people are talking about this, both from a practical and ethical standpoint. He introduces topics such as connecting the brain with machines, reading the brain, and manipulating the brain, for both enhancement and degradation purposes. In essence, he served as a trailblazer to awaken the public to neuro S&T applications in the national security space.

Dr. James Giordano, a Georgetown University neuroscientist and neuroethicist, is considered by many to be the leading scholar and public speaker on neuro applications for national security. He's spoken on neuroscience in many forums including universities, think tanks, military schools, national laboratories, policymakers, and even to USSOCOM. A simple search of his name on YouTube unveils dozens of speeches he's given on this topic and reveals the depth of his thinking in this discipline. Along with numerous scholarly articles, he edited a 2-part book series titled *Advances in Neurotechnology*, bringing in leading scientists to discuss the potential and implications, which included a 2012 book titled *Neurotechnology: Premises, Potential, and Problems* that discusses the larger technical, ethical, legal, and cultural issues from neuro S&T,[21] and a 2014 book titled *Neurotechnology in National Security and Defense: Practical Considerations, Neuroethical Concerns* that focuses specifically on military and law enforcement issues and applications.[22] Both are great resources for a deeper understanding of the science and the impacts of neuro S&T on national security.

Finally, the most recent book to dive into neuro S&T from a military perspective came in 2017 from Dr. Armin Krishnan, a Security Studies professor from East Carolina University, titled *Military Neuroscience and the Coming Age of Neurowarfare*. This book

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[20] Jonathan D. Moreno, *Mind Wars: Brain Research and National Defense* (New York: Dana Press, 2006).

[21] James J. Giordano, ed., *Neurotechnology: Premises, Potential, and Problems*, Advances in Neurotechnology (Boca Raton: CRC Press, 2012).

[22] James Giordano, *Neurotechnology in National Security and Defense: Practical Considerations, Neuroethical Concerns* (CRC Press, 2014).

updates the literature on current and future neurotechnologies. It is the most comprehensive review of the potential and limitations of neuro S&T research from a national security perspective, and also begins to scratch at the larger strategic implications of the impending neurowarfare, arguing that nonlethal strategies will grow in importance during the 21st century as mind manipulation becomes increasingly powerful and prevalent, a position the authors of this paper agree with.[23]

Many of the themes, ideas, and discussion for this thesis stems from the continuing work of these three authors, among others. However, this paper examines the current use of neuroweapons, adds a larger context of how they developed and how they can be used for strategic purposes, and how U.S. adversaries view neurowarfare.

D. TECHNOLOGY'S INFLUENCE ON WARFARE

While introducing the concept of neurowarfare can seem fanciful and dubious, it is only a continuing trend of warfare rapidly expanding to new areas of scientific progress. While the land and sea have been domains of warfare for millennium, only in the past century has the air domain, and only within the past few decades have space and cyberspace been weaponized. These new domains became part of the battlespace because science and technology (S&T) evolved to explore and unlock many of their secrets.

This paper argues that S&T, specifically in the area of neuro S&T, is unlocking the mind as the next frontier in scientific and technological progress which is already leading to an era of neurowarfare. The potential has been understood for quite some time, but only recently has science begun to turn potential into reality. In 1967, Dr. Richard Heilbroner, famous American economist, historian, and author, opined that the expansion of knowledge is gradual in society and leads to a pattern of technological evolution. Technological progress drives "loosening constraints" that lead to future discoveries and areas of progress:

> Particularly from the mid-nineteenth century to the present do we sense the loosening constraints on technology stemming from successively yielding barriers of scientific knowledge—loosening constraints that result in the

[23] Krishnan, *Military Neuroscience and the Coming Age of Neurowarfare*.

> successive arrival of the electrical, chemical, aeronautical, electronic, nuclear, and space stages of technology.[24]
>
> Indeed, as the twentieth century has progressed, science has become a major historical force in its own right and is now the indispensable precondition for an effective technology.[25]

All of the aforementioned areas of scientific exploration (electrical, chemical, aeronautical, electronic, nuclear, and space), and many others not discussed, were eventually translated into military purposes. In fact, most were discovered, initially developed, and refined purely for their military utility before translating to civilian purposes, which is a common theme across history. In 1996, Dr. Eliot Cohen, prominent academic and now-current Dean of the Paul H. Nitze School of Advanced International Studies (SAIS) at Johns Hopkins University, wrote a seminal article titled "A Revolution in Warfare," in which he cautions observers to temper their expectations for the revolution in military affairs (RMA) brought through the ubiquity of information systems, commonly referred to as a *system of systems*: "The cautious military historian (and even more cautious soldier) looks askance at prophets of radical change, although by no means at change itself. Unquestionably, military technology has never stood still."[26] While military technology is always changing, it is difficult to predict how important military technology will be to future warfare, since there are many variables at play and it is difficult to isolate their effects.

Twenty-five years after Cohen wrote his article, information systems have multiplied in form and function, playing a crucial role as a driver in many industries. Both the United States as a society and the U.S. military is wholly dependent on information, which leads to increasing vulnerability, first to cyber-attacks, but then to information attacks through manipulation. The center of gravity for manipulation is ultimately the human brain, as different people perceive reality through their own lens of perception.

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[24] Robert L. Heilbroner, "Do Machines Make History?," *Technology and Culture* 8, no. 3 (July 1967): 338, https://doi.org/10.2307/3101719.

[25] Heilbroner, 345.

[26] Eliot A. Cohen, "A Revolution in Warfare," *Foreign Affairs* 75, no. 2 (March - April 1996): 38, https://doi.org/10.2307/20047487.

Cohen also aptly summarizes how military change diffuses into the political space: "Revolutionary change in the art of war stems not simply from the ineluctable march of technology but from an adaptation of the military instrument to political purposes."[27] From a strategic standpoint, this thesis makes the case that the instruments, tools, and impacts necessary for neurowar are increasingly similar to the same tools needed for political power, thus increasing the likelihood of their continued development, employment, and implementation. Information manipulation has become increasingly valuable, but as awareness is raised, the value will decrease, thus necessitating a response to go further towards direct brain manipulation, and eventually control. This point makes neurowarfare likely to proliferate in the near future.

Neuro S&T is one of the latest and potentially most important frontier of science due to the ways science is beginning to unlock the brain's secrets. To be clear, this will be a long endeavor, and the scientific community is still many decades from completely realizing, if ever. But the journey has indeed started. As early as 2002, Cohen presciently recognized the fundamental importance of the revolution in biology, and its impending implications on warfare:

> The biological sciences increasingly make it possible to change the nature of human beings themselves…One can scarcely doubt that an Adolf Hitler, or for that matter a Saddam Hussein, would have availed himself of the resources of biotechnology to breed new kinds of human beings—super-soldiers, for one thing, insensitive to fear and truly loyal to the death—who could serve his purposes.[28]

E. THESIS OVERVIEW

This paper aims to better inform mid-career military practitioners and policymakers about developments in the militarization of neuro S&T leading to an era of neurowarfare. There are many issues to discuss for awareness and preparation of the operational environment, including the categorization and means of neurowarfare, the current usage,

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[27] Cohen, 51.

[28] Eliot Cohen, "Technology and Warfare," in *Strategy in the Contemporary World: An Introduction to Strategic Studies*, ed. John Baylis et al., 1st ed. (Oxford ; New York: Oxford University Press, 2002), 251.

the larger strategic context, and how U.S. adversaries view neurowarfare. One area that is outside the scope of this paper is the ethical considerations of neuro S&T and its applications to warfare, but the authors acknowledge the issues are many and heated. Some have voiced concern that if the United States does not engage, others will, leading to impending weakness. In 2002, Cohen himself highlighted the nature of technological progress in military affairs: "To the extent that the revolution proceeds from forces in the civilian world, the potential will exist for new military powers to emerge extremely rapidly. A country like Japan or, in a few years, China will quickly translate civilian technological power into its military equivalent."[29]

This paper is laid out in the following manner. Chapter II provides a historical look at neurowarfare in an attempt to define, explore, and categorize the field. It also gives an overview of the neuro S&T research, while noting its potential and implications for the military on future warfare. Chapter III is an in-depth case study into how neurowarfare is currently being waged against the United States in today's environment, by exploring the practices, locations, effects, and implications of the known cases of Havana Syndrome. Chapter IV is an exploration of the current strategic context the United States finds itself in in order to understand the nature of the current struggle in foreign affairs and the motivations behind strategic competitors, including their focus on influence. Chapter V looks at the mindset and current public activities of neurowarfare conducted by the United States' two, current, biggest competitors—China and Russia. Chapter VI summarizes with conclusions, recommendations, and suggested future research. If the reader is still not convinced that neurowar is here, the appendix includes many of the organizations in the national security space, and specifically the DOD, that are developing neuro S&T into specific applications, demonstrating their wide-ranging utility.

[29] Cohen, "A Revolution in Warfare," 51.

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II. NEURO S&T AND NEUROWARFARE

> The human brain has 100 billion neurons, each neuron connected to 10,000 other neurons. Sitting on your shoulders is the most complicated object in the known universe.
>
> —Dr. Michio Kaku, theoretical physicist and bestselling author, 2014[30]

> Can we someday read memories by measuring the activity of the brain? Can our brains someday be "plugged" into computers?
>
> —Dr. Richard Thompson, neuroscientist, 2007[31]

This chapter serves as a broad primer for neuro S&T in general, and military S&T in particular. It begins with the development and early application of neuroscience to provide context on the age of the industry. It continues with highlights from early government efforts in this realm, focusing on the public's fascination with mind control, and continues with more recent efforts by the government to coordinate brain R&D. The bulk of the chapter is dedicated to defining and categorizing neuro S&T into two broad categories: performance enhancement and performance degradation. Included is a discussion on current lines of effort and future military applications within each of these categories. A further discussion on specific efforts is continued in the appendix. The chapter concludes with a broad foundation to the legal challenges in this area. Weaved throughout are the potential and implications of militarizing neuro S&T on the future. The theme is, based on the history of technological progress in other realms and the current technology that is unlocking ways to read and understand the brain, governments will continue to develop, refine, and employ neuro S&T to further national security ends. It is also inevitable that adversaries will try to make strategic gains in this area, similar to how

[30] Leonard Lopate Show, "Behold the Most Complicated Object in the Known Universe," WNYC, accessed August 3, 2021, https://www.wnyc.org/story/michio-kaku-explores-human-brain/.

[31] Richard F. Thompson and Stephen A. Madigan, *Memory: The Key to Consciousness* (Princeton, N.J. ; Oxford: Princeton University Press, 2007), vi.

they are currently exploiting gaps in irregular manners. The overarching conclusion from the available evidence is that future technological breakthroughs in neuro S&T may revolutionize and alter human society, human consciousness, and war, leading to a new domain of warfare.[32]

A. DEVELOPMENT AND EARLY APPLICATION OF NEUROSCIENCE

Neuroscience, or the study of the human brain and nervous system, is still in its relative infancy. As reflected in the quote above, the human brain is frequently described as the most complex and fascinating object in the universe. Diseases originating in or disrupting brain function are some of the most destructive, including Alzheimer's, Parkinson's, Huntington's, autism, epilepsy, schizophrenia, depression, and traumatic brain injury (TBI), among others.[33] The scientific community is learning more each day, and will continue to advance over the coming decades.

The father of modern neuroscience, Santiago Ramon y Cajal, revolutionized the study of the nervous system only a little more than a century ago with his scientific drawings illustrating how individual neurons form the building blocks of the brain.[34] Winning a Nobel prize in 1906, his drawings still form the basis of understanding that propelled this scientific field into the 20th century, illuminating how neural networks form an intricate arrangement of connections without actually touching.[35] In essence, he depicted the first understanding of the central nervous system, and how the brain and spinal cord communicate with one another.

Recently, science has discovered the brain has nearly 100 billion neurons and 100 trillion connections, which is an almost unfathomable number.[36] Dr. Kaku, in his book *The*

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[32] Krishnan, *Military Neuroscience and the Coming Age of Neurowarfare*, 1.

[33] The BRAIN Initiative, "Overview" (NIH), accessed March 2, 2021, https://braininitiative.nih.gov/about/overview.

[34] Roberta Smith, "A Deep Dive Into the Brain, Hand-Drawn by the Father of Neuroscience," *The New York Times*, January 18, 2018, sec. Arts, https://www.nytimes.com/2018/01/18/arts/design/brain-neuroscience-santiago-ramon-y-cajal-grey-gallery.html.

[35] Smith.

[36] The BRAIN Initiative, "Overview."

Future of the Mind: The Scientific Quest to Understand, Enhance, and Empower the Mind, has described the current era as the golden age of neuroscience due to advances in technology that allow examination in unlocking some of the complexities:[37] "We've learned more [about the human brain] in the last 10 to 15 years than in all of human history combined."[38] In his book, he describes how science is increasingly experimenting with science-fiction-like ideas, from telepathy, mind control, avatars, psychokinesis, and transcribing thoughts, dreams, and memories.[39] He even goes so far as to predict a future where brains can be uploaded to a computer, where thoughts and emotions can be understood and transported via a "brain-net," and where pills can be taken to make us smarter.[40] These predictions serve as a roadmap for what the neuro S&T community hopes to accomplish in the near future.

While science has illuminated a great deal with respect to the human brain, two things have remained constant and clear: (1) the brain is an incredibly complex organ with vast potential that is still barely comprehended, and (2) its malleable nature provides both opportunities and vulnerabilities, especially as they relate to warfare. This next section will briefly explore governments' past efforts to harness the power of the brain and the public's captivation with mind control.

B. EARLY U.S. GOVERNMENT EFFORTS

Richard Condon's novel *The Manchurian Candidate*, written in 1959 during the height of suspicion about communist totalitarianism and subversion and later made into a major motion picture, describes a group of American military members who were kidnapped and brainwashed during the Korean War. The aim was to assassinate a presidential candidate with the goal of installing a communist puppet.[41] In reality, there

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[37] Michio Kaku, *The Future of the Mind: The Scientific Quest to Understand, Enhance, and Empower the Mind*, First edition (New York: Doubleday, 2014).

[38] Leonard Lopate Show, "Behold the Most Complicated Object in the Known Universe."

[39] Kaku, *The Future of the Mind*.

[40] Kaku.

[41] Richard Condon, *The Manchurian Candidate* (New York: Jove, 1988).

was a concerning episode where U.S. military prisoners-of-war (POWs) during the Korean War were coerced into signing war-crime confessions, with twenty-one Americans refusing repatriation. Forced confessions are nothing new, but refusing to come home is a big deal. It demonstrates the magnitude of control brainwashing could potentially have on an individual. This stoked fear within the military community and population about the potency of brainwashing.[42] At the time, in the height of the Cold War, the United States was reeling from fears of communism due to numerous spies who were selling state secrets to the Soviets, including Klaus Fuchs, a German theoretical physicist, and Julius and Ethel Rosenberg, the first American civilians to be executed for espionage.[43] This ultimately led to the anti-communist McCarthy hearings and provided culturally fertile ground for Condon's novel to gain traction in the United States. But as was later discovered, the government was already using the concept behind *The Manchurian Candidate* to test for validity.

In general, there is a history of governments attempting to use neuroscience to gain a competitive advantage against adversaries. We highlight a few notable examples, but our discussion is far from exhaustive. One of the most famous incidents in the United States occurred during the height of the Cold War in the 1950s and '60s called "Project MKUltra," in which the CIA conducted human experiments in the hopes of exploiting mind control through hypnosis, electro-shock, sensory deprivation, isolation, verbal and sexual abuse, torture, and experimental drugs, including LSD, among other techniques.[44] Although many documents were destroyed about the highly-classified program, as recently as December 2018 the U.S. government was still declassifying and releasing new information

[42] Lorraine Boissoneault, "The True Story of Brainwashing and How It Shaped America," *Smithsonian Magazine*, May 22, 2017, https://www.smithsonianmag.com/history/true-story-brainwashing-and-how-it-shaped-america-180963400/.

[43] Ronald Radosh and Joyce Milton, *The Rosenberg File*, 2nd ed. (New Haven: Yale University Press, 1997).

[44] J.H., *Project MKULTRA, The CIA's Program of Research In Behavioral Modification: Joint Hearing before the Select Committee on Intelligence*, 95th Congr. 1 (1977), August 3, 1977, https://www.andrew.cmu.edu/user/rp3h/lansberry/mkultra.pdf.

about the program.[45] John Marks wrote a comprehensive account in his book titled, *The Search for the "Manchurian Candidate": The CIA and Mind Control: The Secret History of the Behavioral Sciences*, which used primary sources to uncover many of the operational-level details.[46] Over 80 institutions were involved in experiments, ranging from universities, hospitals, prisons, pharmaceutical companies, and other front organizations, often on unwitting subjects.[47] Of course, this program was largely a response to overblown fears of Soviet and Chinese Communist thought-control, otherwise known as brainwashing, similar to what Condon conceived in *The Manchurian Candidate*.

Numerous other authors have attempted to piece together government efforts to use neuro S&T for military and national security ends, despite the protests and desired secrecy of those governments. While usually filled with ungrounded speculation and conspiracy theories that attract public attention, Ronald McRae, a credible journalist working under the tutelage of Pulitzer Prize winning investigative journalist Jack Anderson, documented American and Soviet efforts in his 1984 book, *Mind Wars: The True Story of Government Research into the Military Potential of Psychic Weapons*.[48] His efforts focus on military applications of "psi," or extra sensory perceptions, otherwise known as various forms of psychic warfare. McRae explicitly stated psi was not viable based on his interpretation of the evidence; however, many details remain clouded in secrecy.

The issue is further complicated by the fact that neither scientists nor government officials want to speak on the record regarding both what projects they are experimenting with or whether they are having success. Nevertheless, a respected congressman named Charlie Rose (D-N.C.), who served 12 terms in the House of Representatives and was a

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[45] Andrew Whalen, "How the CIA Used Brain Surgery to Make Six Remote Control Dogs," *Newsweek*, December 7, 2018, https://www.newsweek.com/cia-mkultra-documents-files-remote-control-dogs-1250519.

[46] John Marks, *The Search for the "Manchurian Candidate": The CIA and Mind Control: The Secret History of the Behavioral Sciences* (New York: Norton, 1991).

[47] Nicholas M. Horrock, "80 Institutions Used in C.I.A. Mind Studies," *The New York Times*, August 4, 1977, sec. Archives, https://www.nytimes.com/1977/08/04/archives/80-institutions-used-in-cia-mind-studies-admiral-turner-tells.html.

[48] Ronald M. McRae, *Mind Wars: The True Story of Government Research into the Military Potential of Psychic Weapons*, 1st ed (New York: St. Martin's Press, 1984).

member of the House Select Committee on Intelligence and thus had access to classified information, realized the strategic importance back in the 1980s when he supported funding efforts. He stated, "They [neuroweapons] could make every other weapon obsolete."[49]

Jumping ahead to current times, the next section will explore recent government efforts to advance neuro S&T.

C. THE BRAIN INITIATIVE

The U.S. government has a national interest in furthering scientific R&D by coordinating and funneling money towards intellectual pursuits that further human progress. As is the case in many scientific areas, most neuro S&T research originates in universities, laboratories, and the private sector, but is spurred on through government grants and contracts, and converted to suit government purposes. It is within these organizations that civilian-developed technology will likely be translated into military applications, a term known as dual-use technology.

Recent government efforts to synchronize neuro S&T research originated in 2013 through the BRAIN Initiative. President Obama marshalled the BRAIN Initiative (Brain Research through Advancing Innovative Neurotechnologies), a National Institute of Health (NIH)-directed, public-private research plan to further understanding of the human brain by coordinating and integrating multiple scientific communities, companies, agencies, universities, organizations, and other countries.[50] This initiative was inspired by "The Human Genome Project" (HGP) that mapped all 30,000 genes in the human genome. There are 100 billion neurons in the brain, so the project size, scope, and complexity differs dramatically from the 13-year HGP.[51] The initial BRAIN Initiative plan included committing $100 million in federal money and $200 million in private money every year

[49] McRae, xxvi.

[50] The BRAIN Initiative, "Overview."

[51] National Human Genome Research Institute, "Human Genome Project FAQ," Genome.gov, accessed August 4, 2021, https://www.genome.gov/human-genome-project/Completion-FAQ.

towards neuro S&T, but will most likely far surpass those goals.[52] Through 2019, the NIH has allocated over 700 grants totaling $1.3 billion, while requesting $4.5 billion total from 2013–2025, the current project timeline.[53]

Many government organizations besides the NIH are partnered in this initiative, including the National Science Foundation (NSF), the Food and Drug Administration (FDA), the Defense Advanced Research Projects Agency (DARPA), the Intelligence Advanced Research Projects Activity (IARPA), and the Military Services, among others.[54]

The Brain Initiative has spawned similar initiatives and unified research around the world, integrating domestic R&D organizations throughout Europe and East Asia. The European Union (EU) has devoted $1.34 billion for its decade-long endeavor called the Human Brain Project (HBP).[55] Additionally, Japan's national project, called Brain Mapping by Integrated Neurotechnologies for Disease Studies (Brain/MINDS), is a similar effort to coordinate research.[56] Why the push? Besides furthering human development, there is a lot of money to be made. As far back as 2013, the neurotechnologies market potential was estimated at more than $150 billion annually, and projected spending in Asia and South America was set to surpass the West by 2020.[57] The true number now is likely much higher with rising healthcare costs.

In the 21st century, increased research, development, and innovation in the field of neuro S&T, combined with biotechnology, nanotechnology, and artificial intelligence (AI), has created a huge market to capitalize on the vast potential of the human brain. This has

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[52] Tim Requarth, "This Is Your Brain. This Is Your Brain as a Weapon.," *Foreign Policy*, September 14, 2015, https://foreignpolicy.com/2015/09/14/this-is-your-brain-this-is-your-brain-as-a-weapon-darpa-dual-use-neuroscience/.

[53] The BRAIN Initiative, "Overview."

[54] The BRAIN Initiative.

[55] Requarth, "This Is Your Brain. This Is Your Brain as a Weapon."

[56] "Objectives," Brain/MINDS, accessed August 6, 2021, https://brainminds.jp/en/overview/objectives.

[57] Sarah Canna, "Leveraging Neuroscientific and Neurotechnological Developments with a Focus on Influence and Deterrence in a Networked World" (Carnegie Endowment Neurodeterrence Workshop, October 18, 2013), 6, https://carnegieendowment.org/files/U_NeuroDeterrence_Workshop_Approved_for_Public_Release_31Jan14v2.pdf.

led to entirely new industries and commercial development. The benefits are obvious: grow the economy, provide better healthcare and quality-of-life, and further human development. Much of the origin can be traced to new brain-imaging technology that is providing a clearer and more detailed understanding of how the brain works, leading to successive breakthroughs. From 2000 to 2009, only around 400 neurotechnology patents were filed annually.[58] Then from 2010 to 2014, neurotechnology patents doubled from 800 to 1,600 annually.[59] As of 2015, the last year data is available, there were over 8,000 active patents with over 5,000 pending applications, driven largely by activity in the United States and the EU.[60] The market potential in the civilian sector is astronomical, which drives investment, but this paper is focused on military and national security potential. Neuro S&T advances are happening rapidly as new discoveries diffuse, are quickly expanded, and lead to even more discoveries, encompassing multiple applications.

This neuro S&T R&D funding has seeped into the national security arena for national security purposes, with DARPA leading efforts as the pathfinder organization for the DOD.

D. DARPA

The largest investor and supporter of the BRAIN initiative inside the DOD is DARPA.[61] Created in 1958 as the DOD's foremost research and development organization, DARPA is charged with creating breakthrough technologies and capabilities

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58 "Surge in U.S. 'Brain-Reading' Patents," *BBC News*, May 7, 2015, sec. Technology, https://www.bbc.com/news/technology-32623063.

59 Unnati Mehta, Brian Barnett, and Jennifer Buss, "Trends in Neurotechnology" (Arlington, VA: Potomac Institute for Policy Studies, August 2015), 5, https://www.potomacinstitute.org/images/stories/publications/NeuroTrendsAug2015.pdf.

60 Alvaro Fernandez, "Pervasive Neurotechnology: A Groundbreaking Analysis of 10,000+ Patent Filings Transforming Medicine, Health, Entertainment, and Business," *SharpBrains* (blog), May 3, 2015, https://sharpbrains.com/downloads/pervasive-neurotechnology-a-groundbreaking-analysis-of-10000-patent-filings-transforming-medicine-health-entertainment-and-business/.

61 Robbin A. Miranda et al., "DARPA-Funded Efforts in the Development of Novel Brain–Computer Interface Technologies," *Journal of Neuroscience Methods*, Brain Computer Interfaces; Tribute to Greg A. Gerhardt, 244 (April 15, 2015): 54, https://doi.org/10.1016/j.jneumeth.2014.07.019.

for national security.[62] With an annual budget around $3.5 billion, DARPA is leading U.S. military innovation efforts in many areas, but specifically neuroscience.[63] In 2014, recognizing the bio-revolution underway, DARPA set up the Biological Technologies Office (BTO) to harness game-changing biological technologies, with a specific interest in neuro S&T.[64] The focus, at least from what is publicly available, is only on neuro performance enhancement (described later in this chapter), as the DOD has rightly recognized the benefits neurotechnologies can have on military members in many capacities.[65] The research indicates science is not far from future applications such as fusing computer systems and neural networks to increase the cognitive performance of humans and control armies of robotic machines with only thoughts. Dr. Al Emondi, a neuroscientist and electrical engineer, who is a program manager within BTO, summarized their goals:

> Our No.1 goal is to develop communications links to the brain that do not require surgery. A high-performance, noninvasive neural interface would open up possibilities such as immersive training, new forms of interaction with AI systems, improved situational awareness and intelligence analysis, and distributed task management with machines to speed tactical decision-making and free up cognitive function for strategic planning. It's a potentially foundational technology for the next generation of DOD systems.[66]

DARPA began its interest in the intersection of man and computers in the 1960s when it hired J.C.R. Licklider, the famous author of "Man-Computer Symbiosis" in which he provided the intellectual underpinnings of the computer revolution, leading eventually

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62 "About DARPA," DARPA, accessed August 11, 2021, https://www.darpa.mil/about-us/about-darpa.

63 Department of Defense, *DOD Fiscal Year 2022 Budget Estimates: DARPA Defense-Wide Justification Book*, vol. 1, 5 vols. (Washington, DC: Department of Defense, 2022), https://www.darpa.mil/attachments/DARPA_PB_2022_19MAY2021_FINAL.pdf.

64 Justin Sanchez and Jacob Jordan, "The Evolution of Defense Technology: DARPA's Biological Technologies Office," *Defense Media Network*, January 23, 2019, https://www.defensemedianetwork.com/stories/the-evolution-of-defense-technology-darpas-biological-technologies-office/.

65 Michael Joseph Gross, "The Pentagon's Push to Program Soldiers' Brains," *The Atlantic*, November 2018, https://www.theatlantic.com/magazine/archive/2018/11/the-pentagon-wants-to-weaponize-the-brain-what-could-go-wrong/570841/.

66 Sanchez and Jordan, "The Evolution of Defense Technology."

to ARPANet, the precursor to the Internet.[67] In 1974, another innovative offshoot in brain-computer interface (BCI), led to the *Close-Coupled Man/Machine Systems* program: "This program investigated the application of human physiological signals, including brain signals as measured non-invasively using either electroencephalography (EEG) or magnetoencephalography (MEG), to enable direct communication between humans and machines and to monitor neural states associated with vigilance, fatigue, emotions, decision-making, perception, and general cognitive ability."[68] It is precisely breakthroughs like this that give DARPA it's renowned reputation for technological progress.

In the early 2000s, as science was advancing along many fronts, DARPA accelerated its investments into neuro S&T.[69] The 2003 DARPA Strategic Plan explicitly framed the fundamental challenge with the game-changing potential, stating, "The long-term Defense implications of finding ways to turn *thoughts into acts*, if it can be developed, are enormous: imagine U.S. warfighters that only need [to] use the power of their thoughts to do things at great distances."[70]

Throughout the past two decades, numerous programs have advanced not only brain understanding, but more importantly brain applications, laying the foundation for more compact and powerful BCIs as new advances occur.[71] Sharon Weinberger, a journalist and author on defense issues, in her 2017 book, *The Imagineers of War: The Untold History of DARPA, the Pentagon Agency that Changed the World,* discusses DARPA's attempts at "augmented cognition," or using brain-machine interfaces to read

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[67] MIT 150 Exhibition, "Man-Computer Symbiosis" (MIT), accessed August 14, 2021, http://museum.mit.edu/150/30.

[68] Miranda et al., "DARPA-Funded Efforts in the Development of Novel Brain–Computer Interface Technologies," 54.

[69] Justin Sanchez and Robbin Miranda, "Taking Neurotechnology into New Territory," *Defense Media Network*, March 14, 2019, https://www.defensemedianetwork.com/stories/taking-neurotechnology-new-territory/.

[70] DARPA, *Strategic Plan* (Washington, DC: Defense Advanced Research Projects Agency, 2003), 19, https://www.hsdl.org/?search=&searchfield=&all=strategic+plan+darpa&collection=public&submitted=Search.

[71] Sanchez and Miranda, "Taking Neurotechnology into New Territory."

people's thoughts.[72] She also claims DARPA's neuro S&T efforts could revolutionize both medicine and weapons, and by extension warfare writ large: "Neuroscience could transform the world by revolutionizing medicine, and it could lead to weapons that change the way we fight future wars. Whether that world will be a better place is unclear."[73]

A common operating model for DARPA is to invest in the initial stages of programs, helping to transform ideas and concepts into reality, then once proven successful, to transfer programs to the individual Military Services to adapt to their specific needs in order to become programs of record: "What DARPA does is we provide a fundamental tool so that other people can take those tools and do great things with them that we're not even thinking about."[74] The range of DARPA neuro S&T programs, past and present, cover a variety of neuro-challenges in innovative ways, from revolutionizing prosthetics in injury recovery, to better integrating man and machine, to treating TBI and other neural impairments more effectively, to improving human training and performance.

As this section demonstrates, DARPA is the imaginative leader in pursuing new technologies for national security purposes, although many have dual-use applications. Neuro S&T is clearly a high priority for the organization based on the potential, and appears increasingly likely to integrate into numerous, wide-ranging military applications in the near future. Many of DARPA's initial program successes are now being tailored and adapted into specific Service purposes, with numerous research being conducted inside the Service R&D umbrella organizations. Please see the appendix for a further discussion and list of various U.S. DOD and military organizations and their current work on neuro S&T R&D.

This explosion of funding and research in neuro S&T has created the need to distinguish and categorize the different overall purpose of research and clarify lines of efforts.

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[72] Sharon Weinberger, *The Imagineers of War: The Untold History of DARPA, the Pentagon Agency That Changed the World* (New York: Alfred A. Knopf, 2017), 322.

[73] Weinberger, 372.

[74] Gross, "The Pentagon's Push to Program Soldiers' Brains."

E. CATEGORIZING NEUROTECHNOLOGIES

A 2012 report by the United Kingdom's Royal Society, titled *Brain Waves Module 3: Neuroscience, Conflict, and* Security, classifies the applications of neuro S&T into two broad camps: *performance enhancement* and *performance degradation*.[75] Both Giordano and Krishnan have used this framework and incorporated their own interpretations.

1. Performance Enhancement

Performance enhancement tools seek to amplify the capabilities of the brain in such ways as improving cognitive performance, sensor perception, memory, concentration, motivation, and situational awareness, while at the same time negating the ills associated with decreased sleep, stress, pain, fear, harmful memories, and other negative emotions. Performance enhancement techniques are generally considered positive, as discoveries will diffuse to a range of applications in the civilian sector, thus increasing quality of life for future populations. However, advancing neuro S&T is not without risks, as some have voiced concerns over tampering with the mind and creating "super soldiers" due to potential negative consequences depending on how enlightened, moral, and autonomous they would operate.[76] Furthermore, there are myriad ethical issues that come with experimenting and altering the human brain.

There are three broad categories of performance enhancements: (1) *Neuropharmacology* uses drugs designed to target specific areas of the brain.[77] (2) *Brain stimulation* comprises sending electric currents to specific areas of the brain, which has shown positive effects for everything from basic learning to cognitive impairments.[78] (3) *Brain-computer interfaces,* or BCI—sometimes referred to as neural interface systems

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[75] Royal Society, *Brain Waves Module 3: Neuroscience, Conflict and Security* (London: Royal Society, 2012), iii, https://royalsociety.org/-/media/Royal_Society_Content/policy/projects/brain-waves/2012-02-06-BW3.pdf.

[76] James Giordano, "Weaponizing the Brain: Neuroscience Advancements Spark Debate," *National Defense*, May 11, 2017, https://www.nationaldefensemagazine.org/articles/2017/5/11/weaponizing-the-brain-neuroscience-advancements-spark-debate.

[77] Kenneth Ford and Clark Glymour, "The Enhanced Warfighter," *Bulletin of the Atomic Scientists* 70, no. 1 (January 1, 2014): 43–53, https://doi.org/10.1177/0096340213516746.

[78] Giordano, *Neurotechnology in National Security and Defense*, 172.

(NIS), and can also more broadly be considered a type of human-machine interface (HMI)—involve opening up pathways to connect the brain to a computer to allow the two-way flow of information, either to download information such as programming new learning, behaviors, or actions, or upload to external machines and devices for control in order to enhance physical capabilities.[79] It is easy to consider the possible military applications for these types of performance-enhancing tools.

a. Neuropharmacology

Militaries for centuries have used drugs to increase the performance of their troops, using alcohol, caffeine, nicotine, even cocaine, opioids, and amphetamines, including "Japanese meth" and "Nazi meth" during World War II.[80] Neuroscience is likely to continue developing more advanced drugs that can gage, target, and enhance specific brain function, becoming as common as taking a pill. Right now, new technologies that could be game changers include drugs that target and deliver precise effects using nanotechnology to breach the blood-brain barrier.[81] These drugs are already treating common and advanced brain disorders. Such technology could open up entire new endeavors. The National Research Council of the National Academies has stated, "Changes in models of brain function may create new and surprising ideas about how, when, where, or why drugs produce their effects; about what those effects are; about the kinds of chemicals that function as drugs to alter human functioning; and about ways to enhance, minimize, or counteract drug effects."[82]

In the future, military commanders may not only be able to *monitor* but also *control* the mental performance of the troops under their command, by increasing performance without sleep, controlling emotions under stress or pain, and thinking through emerging

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[79] Patrick A. Cutter, "The Shape of Things to Come: The Military Benefits of the Brain-Computer Interface in 2040:" (Fort Belvoir, VA: Defense Technical Information Center, April 1, 2015), https://doi.org/10.21236/AD1012768.

[80] Armin Krishnan, "Attack on the Brain: Neurowars and Neurowarfare," *Space & Defense* 9, no. 1 (Spring 2016): 7.

[81] National Research Council, *Emerging Cognitive Neuroscience and Related Technologies* (Washington, DC: The National Academies Press, 2008), 42, https://doi.org/10.17226/12177.

[82] National Research Council, 41–42.

threats in creative and innovative ways through targeted drug application in controlled doses.[83] Neuropharmacology also has the potential to develop drugs that increase cognitive performance and treat post-traumatic stress disorder (PTSD), and other mental declines such as dementia and Parkinson's.

b. Brain Stimulation

Right now, brain stimulation technologies have been shown to increase and solidify learning by helping the brain process large amounts of information. Two recent promising advances in brain stimulation technologies include transcranial direct current stimulation (tDCS), which uses a constant, low direct current delivered via electrodes on the head, and transcranial magnetic stimulation (TMS), which uses magnetic fields to stimulate nerve cells in the brain, thus expanding brain capacity and capability.[84] These brain stimulation technologies have been shown to improve shooting accuracy and decision-making speed.[85] These technologies could quickly be adapted to military applications, and are being experimented with now.

Brain stimulation devices mounted on a military member's head provide opportunities for increased cognitive performance. There are ample opportunities during combat where brain stimulation devices could be adapted to existing helmets, whether a soldier on patrol or a pilot in the cockpit. Even more so, they could be tailored to command and control-type positions, where greater understanding of the battlespace and situational awareness provide new ways to think through unfolding engagements with increased clarity for optimal outcomes. Brain stimulation techniques could also be applied in training environments, thus decreasing the need for expensive and complex exercises while tailoring the training to an individual's weaknesses and needs. Such an approach would maximize both effectiveness and efficiency.

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[83] Krishnan, "Attack on the Brain: Neurowars and Neurowarfare," 7.

[84] Giordano, *Neurotechnology in National Security and Defense*, 171–72.

[85] Kaline Rocha et al., "Unskilled Shooters Improve Both Accuracy and Grouping Shot Having as Reference Skilled Shooters Cortical Area: An EEG and TDCS Study," *Physiology & Behavior* 224 (October 1, 2020): 113036, https://doi.org/10.1016/j.physbeh.2020.113036.

c. BCI

BCIs are rapidly advancing in both the civilian and military sector and provide the greatest potential for augmentation. BCIs are already being commercialized as robotic prosthetic limbs and to provide mobility and independence for spinal-cord injuries. They are also being explored as exoskeletons to provide increased strength and protection.[86] DARPA is leading efforts on the military side, with numerous advances. One example is *CT2WS*, or Cognitive Technology Threat Warning System, which is a BCI designed to be a soldier-portable visual threat warning device, integrating cameras with AI and operator brain signals to more accurately identify threats while reducing the cognitive workload on soldiers.[87] Furthermore, USSOCOM is pursuing advances in their hyper-enabled operator (HEO) concept, unveiled in 2019. Special Operations Force Acquisition, Technology & Logistics (SOF AT&L), the organization under USSOCOM responsible for developing and fielding the next generation of capabilities, defines the HEO as "leveraging next-generation capabilities, linked together as a synchronized system with advanced human-machine interface, the HEO has improved human performance and decision-making through integrated hardware and software solutions of combined systems."[88] See the appendix for additional examples.

Once the technology is established, adapting and implementing for specific purposes will be a fast transition. BCIs could provide a pathway between an individual's brain and hardware or software systems as an extension of the human mind. This could entail more and advanced "remotely controlled" military equipment, leaving the human safe and protected. Eventually, entire armies, navies, and air forces could fight against each other using the most advanced equipment without putting a single human at risk. Implantable devices could also enhance cognition by connecting the human brain to such

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86 Robert Bogue, "Exoskeletons and Robotic Prosthetics: A Review of Recent Developments," *Industrial Robot: An International Journal* 36, no. 5 (January 1, 2009): 421–27, https://doi.org/10.1108/01439910910980141.

87 Bruce Sterling, "Augmented Reality: DARPA Cognitive Technology Threat Warning System," *Wired*, September 19, 2012, https://www.wired.com/2012/09/augmented-reality-darpa-cognitive-technology-threat-warning-system/.

88 "Our Organization," SOF AT&L, accessed August 12, 2021, https://www.socom.mil/SOF-ATL/Pages/Our-Organization.aspx.

instruments as an external hard drive, faster memory systems, or stronger processing and computing power, even allowing instantaneous encyclopedic searches simply by thinking.[89] These discoveries would greatly change the acquisition and technology strategy of every military around the globe. Furthermore, BCIs may one day be able to download new knowledge, skills, and abilities (KSA) directly to the precise area of the brain, allowing instantaneous learning similar to the Hollywood blockbuster trilogy *The Matrix*. Once science develops a better understanding of how the brain works, the possible applications are limited only by imagination.

Recent reports estimate one third of all research and development is directed towards military, law enforcement, and other national security purposes.[90] How much more would that increase with the possibilities to transform/revolutionize warfare that also include dual-use technology applicable to the entire population of the planet?

d. Other Military Applications

Beyond just the battlefield, there are numerous neuro S&T applications for recruiting, selection, learning, training, and rehabilitation in military settings.[91] Functional neuroimaging technologies can display both qualitative and quantitative aspects of brain function, unlocking the relationship between brain activity and a specific task, behavior, or stimulus.[92] Imagine scanning a potential recruit during preliminary problem solving experiments to provide an inside look at the neural flexibility, thus helping to facilitate the right type of KSA, and risk thresholds of future personnel. Personnel could even be siphoned into specific career fields that maximize their natural aptitudes, thus changing the entire career field selection process. Such a future was hypothesized with respect to genetic potential in the science-fiction movie *Gattaca*. Brain imaging could also be used as a more advanced form of a polygraph test to detect dishonesty or deception during selection or

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89 National Research Council, *Emerging Cognitive Neuroscience and Related Technologies*, 52.

90 Royal Society, *Brain Waves Module 1: Neuroscience, Society, and Policy* (London: Royal Society, 2011), 100, https://royalsociety.org/-/media/Royal_Society_Content/policy/publications/2011/4294974932.pdf.

91 Royal Society, *Brain Waves Module 3: Neuroscience, Conflict and Security*, 1.

92 National Research Council, *Emerging Cognitive Neuroscience and Related Technologies*, 51.

interrogation.[93] As more neuro S&T develops, it will likely upend every aspect of the military and its current systems and processes.

In the hands of an adversary, all enhancement technologies could be used for degradation purposes, which increases the risk of furthering neuro S&T. The stakes are so high and the incentives so great that it is only a matter of time before these ideas gradually become realities.

2. Performance Degradation

On the other hand, performance degradation tools seek to impair or degrade the capabilities of the brain by decreasing cognitive performance, impairing sensor perception, incapacitating, or potentially killing. Little is being publicly discussed when it comes to degradation, often due to classification issues.[94] Naturally, there is an even stronger desire for governments to maintain secrecy surrounding the latest degradation technology, and thus closely guarded so as to protect trade secrets. If made public, any new discoveries would quickly diffuse, likely leading to a neurowar arms race. Furthermore, there are myriad ethical issues that come with the weaponization of neurotechnologies that directly target the brain.

Defining the term *neuroweapon* has become more complicated and controversial between nations because there is so much gray area, or gray matter—pun intended. There is not a universal, agreed upon definition due to distinguishing between the methods, intended target, and effects of an attack on the brain. Most attempts usually devolve into lawyerly semantics due to numerous overlap between biological weapons, chemical weapons, radiation-based weapons, and cyber weapons. Lines are blurred; there is no clear delineation. Additionally, once it is defined, it can then be regulated and restricted, similar to biological and chemical weapons now.

With those limitations in mind, this thesis considers three definitions. The broadest definition comes from Dr. James Giordano, stating: "The objectives for neuroweapons in

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[93] Royal Society, *Brain Waves Module 3: Neuroscience, Conflict and Security*, 1.

[94] Krishnan, *Military Neuroscience and the Coming Age of Neurowarfare*, 14.

a traditional defense context may be achieved by altering functions of the nervous system, so as to affect cognitive, emotional, and/or motor activity, and capability. Many technologies can be employed to produce these effects…[including] both non-kinetic and kinetic weapons."[95] Dr. Robert McCreight, an academic with experience advising senior leaders at the National Security Council (NSC) and DOS, has suggested defining a neuroweapon by its effects on thoughts and perception: "Neuroweapons are intended to influence, direct, weaken, suppress, or neutralize human thought, brainwave functions, perception, interpretation, and behaviors to the extent that the target of such weaponry is either temporarily or permanently disabled, mentally compromised, or unable to function normally."[96] Finally, academic Dr. Armin Krishnan has attempted to simplify the definition, and it is the one the authors most closely align with: "Neuroweapons are weapons that specifically target the brain or the central nervous system in order to affect the targeted person's mental state, mental capacity and ultimately the person's behavior in a specific and predictable way."[97] Regardless of which definition one uses, a key component includes the physical manipulation of the brain in order to achieve immediate ill effects. A secondary component expands this to include psychological manipulation. Ultimately, this is about influencing, and could involve potentially controlling the most important aspect of a human being—their mind.

The general target of these weapons is the human brain and all its cognitive functions, including thought, perception, memory, learning, and emotions. There are four general categories of neuroweapons: 1) *drugs*, or neuropharmacology, 2) *bugs*, specifically neurological bioweapons, 3) *waves*, short for electromagnetic and sound waves, and 4*) bytes*, or direct information attacks on the brain.[98]

Similar to neuropharmacology on the enhancement front, drugs and other chemical agents could be used for nefarious purposes to incapacitate or influence the emotions and

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[95] Giordano, *Neurotechnology in National Security and Defense*, 81.

[96] Giordano, 117–18.

[97] Krishnan, *Military Neuroscience and the Coming Age of Neurowarfare*, 11.

[98] Krishnan, 97.

behaviors of enemies and noncombatants alike.[99] Examples include causing hallucinations or inducing hypnotic states—potentially to cause hyper suggestibility, manipulate memory, or even induce trust through oxytocin before negotiating a deal to increase the chance of a favorable outcome. At either the tactical or strategic level, this influence and manipulation could lead to any number of outcomes.

Bugs, or biological weapons in the form of viruses, bacteria, and fungi that are genetically engineered to directly attack the brain and nervous system, could incapacitate, injure, disable, or kill personnel in precise manners or may be able to produce tailored behavioral effects.[100]

Waves, or energy carried through different media, including light, radio, and sound waves, can be utilized as weapons if the energy is sufficiently concentrated in space and time. Whether sound waves in the form of sonic and ultrasonic weapons, or electromagnetic waves in the form of radio frequency (RF)-DEW, wave-based weapons are a broad class that uses intense energy to incapacitate, damage, or destroy.[101] Examples include stun weapons such as tasers, lasers, electro-magnetic pulse (EMP), high-powered microwaves (HPM), low-powered waves set at the right frequency, particle beams, and RF/acoustic weapons that impair brain function causing temporary incapacitation and/or death.[102] While these weapon effects can target the entire body, some are felt more sensitively in the brain and/or nervous system and produce lasting effects similar to concussions and sometimes worse depending on the power and severity. Many of these symptoms are commonly referred to as "Havana Syndrome." Chapter III is an in-depth case study of how DEWs are currently being employed by hostile actors today to target the brain.

Interestingly, DEWs were originally explored and considered in the 1960s as a creative way to attack electronic systems: "At that time, three distinct concepts were

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[99] Royal Society, *Brain Waves Module 3: Neuroscience, Conflict and Security*, 9.

[100] Krishnan, *Military Neuroscience and the Coming Age of Neurowarfare*, 106.

[101] Anna de Courcy Wheeler, "Directed Energy Weapons" (Geneva: Article 36, November 2017), https://article36.org/wp-content/uploads/2019/06/directed-energy-weapons.pdf.

[102] Krishnan, *Military Neuroscience and the Coming Age of Neurowarfare*, 117.

considered—high-energy lasers (HEL), HPM, and charged particle (electron) beams (CPB)—with the objective of producing devices with enough power to "hard-kill" targets of interest, such as high-speed missiles."[103] More recent HPM trends from 2005 include getting smaller, stronger, longer range (up to 15 km) and more precise, although operational research remains classified.[104] These trends line up with many other areas of scientific progress, and are a big reason why DEWs remain high priorities for militaries around the globe.

Finally, bytes, or information- and software-based weapons can be a way to "hack the brain."[105] While current examples are limited to tampering with implants or hacking a BCI, as more BCIs proliferate in society the risks to them increase. This could lead to new targets for hackers as BCIs increasingly connect to larger networks, increasing vulnerabilities. However, there is a need to distinguish between indirect information attacks meant to manipulate, which is more commonly associated with psychological warfare and hence not considered a neuroweapon attack, and direct information attacks on the brain.

F. POTENTIAL EFFECTS OF NEUROWEAPONS

There are numerous applications for military utility for each type of neuroweapon, although validation of real-world employment is limited or non-existent due to classification issues. In 2002, in response to Chechen separatists raiding a theatre and holding 800 hostages in Moscow, Russian Special Forces delivered aerosol-based drugs, leaving all unconscious. While Russian forces were able to storm the theatre and kill all hostage-takers, unfortunately 129 of the hostages also died from the drugs, representing a fatality rate of ~16% of hostages.[106] While acknowledging the numerous unknowns in how COVID-19 came into existence, the recent worldwide pandemic has shown the possibilities

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[103] Elihu Zimet and Christopher Mann, "Directed Energy Weapons - Are We There Yet? The Future of DEW Systems and Barriers to Success:" (Fort Belvoir, VA: Center for Technology and National Security Policy, National Defense University, May 1, 2009), 2, https://doi.org/10.21236/ADA501628.

[104] Guoqi Ni, Benqing Gao, and Junwei Lu, "Research on High Power Microwave Weapons," in *2005 Asia-Pacific Microwave Conference Proceedings*, vol. 2, 2005, 4–5, https://doi.org/10.1109/APMC.2005.1606492.

[105] Krishnan, *Military Neuroscience and the Coming Age of Neurowarfare*, 129–30.

[106] Royal Society, *Brain Waves Module 3: Neuroscience, Conflict and Security*, 11.

and effects for biological weapons to rapidly transform societies. It may be possible to develop technology that engineers bugs to specifically target the brain with precise manipulation effects, even possibly based on genetic blueprints for racial or ethnic classes. Waves appear to be the most likely method that is currently available, and they can be debilitating with long-lasting effects similar to concussions. However, currently there is little evidence to show behavioral impacts outside of pure impairment or deterioration, in the form of mind control or forcing behavioral actions. Finally, bytes may become a more likely target once brains are connected to computers, necessitating similar precautions and defenses that cyber systems use now. Many bodily devices that have implantable chips could already be at risk of tampering and manipulation, especially with DEW, thus creating huge vulnerabilities.

Neurowar also has great strategic potential with surgical precision as a form of counter-leadership strategy. If a key member of the operational or strategic chain of command, from military leaders to the SecDef to the President of the United States (POTUS), is targeted in a non-lethal manner during a crisis and is suddenly impaired, there are not fast and easy processes to hand over nuclear launch codes or authorization to strike. In these crisis scenarios, minutes count, and the time to convene cabinet members and certify decisions might be the difference between life and death. This is just a small sample of possible scenarios, but it highlights how serious neurowar could become as the tactics, technology, and strategy evolves.

Of course, there are big differences in the impacts of neuroweapons, creating a spectrum of effects. This has led Finnish professor Dr. Torsti Sirén to classify the impacts on an individual in three categories: 1) mild—inducing sleep or lowering inhibitions, 2) in-between—causing aggressiveness or passivity, and 3) extreme—mental coercion or incapacitation.[107] Due to the emerging nature of this warfare, no consensus has been reached on classifying impacts, nor have any internationally-accepted rules or norms been developed to deter, signal, or respond to such attacks, even as they grow in proliferation.

[107] Torsti Sirén, *Winning Wars Before They Emerge: From Kinetic Warfare to Strategic Communications as a Proactive and Mind-Centric Paradigm of the Art of War* (Boca Raton: Universal-Publishers, 2013), 86.

Chapter III further explores how neuroweapons are being used against the United States with great effect. From a strategic standpoint, there are also soft and hard power dimensions to neuro S&T.

G. NEURO S&T POWER DIMENSIONS

There are both "soft" and "hard" power implications for exercising neuro S&T against competitors. In a soft power capacity, "neuro S&T research and development can be utilized to exercise socio-economic power in global markets."[108] Neuro S&T research can also be a way for improving relationships between states, as scientists from different countries work together toward a common goal of developing potentially life-saving technology. In a hard power capacity, "neuro S&T can be employed to augment friendly forces' capabilities or to denigrate the cognitive, emotive, and/or behavioral abilities of hostiles."[109] They can also serve as a deterrent against an adversary due to the potential wide-ranging effects generated from a neuroweapon. The versatility of these different power dimensions will continue to encourage the development of neuroweapons—especially since there is a lack of legal prohibitions against them—which will be discussed in the next section.

H. LEGALITY

Strikingly, few national laws or international agreements restrict the *weaponization of* or *attacks on* the human brain. While current U.N. treaties against biological and chemical weapons, specifically some neuro-microbiologicals, chemicals, and toxins are prohibited, currently most neuroweapons fall into a legal and regulatory gap, as it does not fit either of these two categories.[110] The two UN disarmament treaties, the Biological and Toxin Weapons Convention (BTWC) (also known as just the BWC – Biological Weapons Convention) and the Chemical Weapons Convention (CWC), which serve as non-binding and non-enforceable mechanisms to restrict weaponization, are typically reactive in nature.

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[108] Joseph DeFranco, Diane DiEuliis, and James Giordano, "Redefining Neuroweapons: Emerging Capabilities in Neuroscience and Neurotechnology," *Prism* 8, no. 3 (January 2020): 49.

[109] DeFranco, DiEuliis, and Giordano, 49.

[110] DeFranco, DiEuliis, and Giordano, 58.

Regulation may be forthcoming, but it is not proactive in addressing emerging neuro S&T. Additionally, as this is a new area of science, many definitions established decades ago are either too broad, vague, or not applicable to potential neuroweapons. Similar to nuclear development, science often forges ahead of political and ethical matters of use, a term called "the Collingridge dilemma" named after the academic who coined it. This is clearly the case for neuroweapons.

Dr. Malcolm Dando, Professor of International Security at the Department of Peace Studies, University of Bradford in the United Kingdom, and author and expert in weapons proliferation, highlighted the potential misuse of advances in neuroscience in his 2015 book, *Neuroscience and the Future of Chemical-Biological Weapons*.[111] In it, he documents the development of neuro S&T under civilian research that has numerous, potentially dangerous, dual-use applications, and explores efforts by the international community to ensure such research is not used for nefarious purposes. He pays particular attention to the ethical, legal, and social implications (ELSI) of neuro S&T, and is more qualified to interpret the trends in science.[112]

Stephen White identified some of these legal challenges in 2008 when he concluded "weapons employing brain-machine interfaces most likely do not violate international humanitarian law. Nevertheless, weapons employing brain-machine interfaces likely will raise novel issues in the jurisprudence of war crimes."[113] Giordano points out that "foreign governments could exploit using health research as a veil to pursue new military neuroscience and technology, and shielding their activities behind commercial norms protecting proprietary and intellectual property."[114] The potential for nefarious activities is likely to grow: "Such risks and threats are greater as neuroscience becomes a more international enterprise and as non-state actors and unregulated states acquire neuro S&T

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[111] Malcom Dando, *Neuroscience and the Future of Chemical-Biological Weapons* (Basingstoke: Palgrave Macmillan, 2015).

[112] Dando, 80.

[113] Stephen White, "Brave New World: Neurowarfare and the Limits of International Humanitarian Law," *Cornell International Law Journal* 41, no. 1 (2008): 178.

[114] Giordano, "Weaponizing the Brain."

capabilities that can be used to achieve new balances of power."[115] As neuroweapons, and their military and societal utility likely expand in the future, the legal and ethical challenges that need to be addressed will become paramount. But the technology is coming our way through numerous lines of effort.

I. CONCLUSION

This chapter has served as a broad primer on military neuro S&T. It included the beginnings of modern neuroscience and early government efforts to use neuroscience for strategic advantage. This chapter also categorized neuro S&T into two camps, performance enhancement and performance degradation, and described the different methods, or lines of effort, within each of these camps, including potential military applications. It concluded with the legal and regulatory gap that neuro S&T currently falls into. Interlaced throughout is the potential and implications of militarizing neuro S&T on the future. It should be clear from the discussion that future technological breakthroughs may revolutionize and alter human society, human consciousness, and war, leading to a new domain of warfare.[116]

Next, we will discuss specific instances of neuroweapon attacks against U.S. officials that, while non-lethal, in essence are still taking qualified and operationally-competent individuals off the playing field, thus creating individual, operational, and strategic impacts.

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[115] DeFranco, DiEuliis, and Giordano, "Redefining Neuroweapons: Emerging Capabilities in Neuroscience and Neurotechnology," 58.

[116] Krishnan, *Military Neuroscience and the Coming Age of Neurowarfare*, 1.

III. HAVANA SYNDROME CASE STUDY

> Many of the distinctive and acute signs, symptoms, and observations reported by DOS employees are consistent with the effects of directed, pulsed radio frequency (RF) energy. Studies published in the open literature more than a half century ago and over the subsequent decades by Western and Soviet sources provide circumstantial support for this possible mechanism.
>
> —National Academy of Sciences, "An Assessment of Illness in U.S. Government Employees and Their Families at Overseas Embassies," 2020[117]

Though the majority of known neurotechnologies fall under performance enhancement, the most prevalent operational use of a presumed neuroweapon for the purpose of degradation is the phenomenon entitled the "Havana Syndrome." Named after the myriad of unexplained symptoms experienced by U.S. government employees at the U.S. Embassy in Havana, Cuba between 2016–2017, Havana Syndrome has grown into a global phenomenon and major national security issue for the United States. Indeed, as of November 2021, more than 200 cases of this syndrome have been reported in at least 16 countries.[118] Table 1 is a compilation of all publicly stated attacks. Of those over 200 cases, almost half of them are CIA officers or their relatives, whereas 60 are DOD or relatives affiliated, and almost 50 are tied to DOS.[119] While the definitive source of these symptoms remains unverified, the most likely culprit is some type of RF-DEW that impacts brain functioning.[120] Also, though there is not a publicly known "smoking gun" that proves a

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[117] National Academies of Sciences, Engineering, and Medicine. 2020, *An Assessment of Illness in U.S. Government Employees and Their Families at Overseas Embassies*, xi.

[118] Ken Dilanian, Josh Lederman, and Courtney Kube, "Up to 200 Americans Have Reported Possible 'Havana Syndrome' Symptoms," *NBC News*, July 20, 2021, https://www.nbcnews.com/politics/national-security/many-200-americans-have-now-reported-possible-symptoms-havana-syndrome-n1274385.

[119] Dilanian, Lederman, and Kube.

[120] SOFWERX, "J5 Donovan Group Radical Speaker Series: Neuroweapons."

particular country is responsible, all available information strongly suggests that Russia is behind these events.

The purpose of this chapter is to conduct a holistic review of all of the known U.S. cases of Havana Syndrome to highlight the frequent use of this emerging capability and enable a better understanding of the growing threat. Although data for this section and the thesis overall are limited to what is unclassified and publicly available, there is enough information in the public domain to glean important lessons. This review will proceed chronologically from when the cases reportedly occurred, provide some background on the technological feasibility of the suspected weapons, and then offer implications and consequences to U.S. national security due to these attacks.

A. DESCRIPTION OF ATTACKS

The following are all the countries and publicly available information surrounding Havana Syndrome cases against U.S. personnel. To our knowledge, this information has not been compiled in the following manner before now.

1. Cuba 2016–2017

Havana Syndrome was first reported at the end of 2016 to the U.S. Embassy in Cuba's by a CIA officer operating under diplomatic cover.[121] The officer reportedly "experienced strange sensations of sound and pressure while in his home, followed by painful headaches and dizziness."[122] Additionally, this same officer had a second incident in early January of 2017, along with four other officers over the next few months.[123] While CIA officers appeared to be the first targets, those affected also included members of the DOS and other employees, as well as their family members, assigned to the Embassy. All told, between 2016 until the United States pulled out most of its diplomatic staff from Cuba

[121] Entous and Anderson, "The Mystery of the Havana Syndrome."

[122] Entous and Anderson.

[123] Entous and Anderson.

in late 2017 in part because of these waves of incidents, there were 40 reported cases of Havana Syndrome, representing about a fifth of the currently known cases globally.[124]

The unexplained illnesses experienced by a diverse range of government officials in Havana was puzzling at the time. It took time for medical officials to synthesize and comprehend what was causing these symptoms. This is understandable due to the ambiguity of the circumstances surrounding the various events, but it was not until the spring of 2017 that it became clear to members of the U.S. government that there was a pattern emerging at the Embassy in Havana, which ultimately delayed investigating the matter in a concerted manner.[125] Nevertheless, personnel assigned to the Embassy at the time understood that if one moved rooms from where they were experiencing pain then the pain would subside, suggesting that whatever was causing the pain was directional and location-specific. This finding was later confirmed by the NAS Report in December 2020.[126] U.S. personnel and their families were primarily affected at their homes and appear to be deliberately targeted. For example, in one case, two embassy workers living in a Havana hotel were impacted but no one else who stayed at that hotel reported any issues.[127] This also demonstrates a level of operational precision not expected by amateurs.

The consequences of these attacks were not just the immediate pain and disorientation experienced by the victims. In many cases, victims are still suffering long-term injuries. Some of these injuries include mild traumatic brain injury, hearing loss, balancing issues, and severe headaches, among other symptoms.[128] Moreover, some of the immediate short-term symptoms were so severe that victims were forced to leave the

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[124] Michele Kelemen, "Senate Panel Told U.S. Is Still Trying To Get To The Bottom Of Havana Syndrome," *NPR*, June 9, 2021, sec. Politics, https://www.npr.org/2021/06/09/1004649165/senate-panel-told-u-s-is-still-trying-to-get-to-the-bottom-of-havana-syndrome.

[125] National Academies of Sciences, Engineering, and Medicine. 2020, *An Assessment of Illness in U.S. Government Employees and Their Families at Overseas Embassies*, x.

[126] Entous and Anderson, "The Mystery of the Havana Syndrome"; National Academies of Sciences, Engineering, and Medicine. 2020, *An Assessment of Illness in U.S. Government Employees and Their Families at Overseas Embassies*, x.

[127] Tracy Connor, Mary Murray, and Abigail Williams, "Victim of Cuba Embassy 'Attacks' Frustrated by Response," *NBC News*, September 19, 2017, https://www.nbcnews.com/news/us-news/cuba-embassy-attacks-baffle-u-s-frustrate-victim-n802326.

[128] Connor, Murray, and Williams.

country for inability to do their work, and eventually the United States decided to curtail a significant amount of its employees at the Embassy in Cuba out of concern for their safety, cooling the recently warming relations between the United States and Cuba.[129]

While there had been much speculation at the time and immediate aftermath of what was causing these symptoms, the aforementioned NAS report later concluded in its 2020 report the most likely cause was RF waves that altered brain functioning.[130] The report itself caveats this conclusion is not definitive and the committee had limited access to data, but nevertheless a directed, pulsed RF energy is the most plausible explanation.[131] As it turns out, whatever this RF weapon is, it was soon used to target U.S. government employees in various other countries throughout the world.

2. Uzbekistan 2017

Not long after the last reported attack happened in Cuba in August 2017, another possible case of the Havana Syndrome occurred in Uzbekistan. In September 2017, a USAID worker and his wife stationed at the U.S. Embassy in Tashkent reported symptoms consistent with those experienced in Cuba and were flown out of the country to be medically examined.[132] Though specific details are still publicly unknown, the fact that this reported event took place in a former Soviet Union country raised suspicions that Russia might be involved in this event, as well as those in Cuba.[133]

3. Russia 2017

One of the more significant cases of Havana Syndrome occurred at the end of 2017 in Moscow, another indication that the Russians likely have a hand in this. Marc

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[129] Will Grant, "US-Cuba Thaw Halted Amid Diplomat Injuries," *BBC News*, September 30, 2017, sec. Latin America & Caribbean, https://www.bbc.com/news/world-latin-america-41452606.

[130] National Academies of Sciences, Engineering, and Medicine. 2020, *An Assessment of Illness in U.S. Government Employees and Their Families at Overseas Embassies*, 2.

[131] National Academies of Sciences, Engineering, and Medicine. 2020, 2.

[132] Steve Dorsey, "Uzbekistan Incident Raises Suspicions of Russian Involvement in Cuba Attacks," *CBS News*, November 28, 2017, https://www.cbsnews.com/news/uzbekistan-incident-raises-suspicions-of-russian-involvement-in-cuba-attacks/.

[133] Dorsey.

Polymeropoulos—a CIA officer for almost three decades and at the time responsible for clandestine operations across Eurasia—visited Russia in December 2017 with the hope of expanding counterterrorism cooperation, despite Russia's reluctance to grant a visa for suspicion he wanted to run cover operations in Russia.[134] Polymeropoulos met with Russian intelligence officers who made it clear to him that they were not happy he was there and lectured him on America's racism, which he assumed was little more than bluster.[135] One night in his hotel room he woke up from his bed with an overwhelming nauseous feeling, and fell over multiple times as he tried to make his way to the bathroom, claiming the "room was spinning around him [and] his ears were ringing," something he initially believed was due to food poisoning.[136] Two days before his trip ended he experienced similar symptoms while out at a restaurant, and, after barely making it back to his room, stayed there for the remainder of his trip unable to move.[137]

After Polymeropoulos returned to the United States, his symptoms continued to get worse over the proceeding months. He began experiencing vertigo, his ears would ring, he lost his long-distance vision, and became unable to drive.[138] His symptoms became so severe that he needed to take increasingly more time off work, ultimately deciding to retire in April 2019 from the CIA after 26 years of service due to persistent headaches.[139]

4. China 2017 and 2018

While the first instances of Havana Syndrome took place in Russia or countries where Russia retains significant influence, in 2017 and 2018 more cases took place in Guangzhou, China, where the United States operates a consulate. The first case occurred when a Commerce Department employee woke up in her bed in late 2017 due to a pulsing, humming sound that not only came from a specific direction but gave her intense pressure

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[134] Julia Ioffe, "The Mystery of the Immaculate Concussion," *GQ*, October 19, 2020, https://www.gq.com/story/cia-investigation-and-russian-microwave-attacks.

[135] Ioffe.

[136] Ioffe.

[137] Ioffe.

[138] Ioffe.

[139] Ioffe.

in her head.[140] She experienced these sounds and sensations for months, and was eventually medically evacuated back to the United States in 2018 where she has lingering effects of the attack, such as memory loss, vision impairment, coordination issues, and a brain scan that is similar to the victims in Cuba.[141] Almost a dozen total consulate personnel were evacuated from China in June 2018 due to suffering from Havana Syndrome symptoms.[142]

5. Poland, Georgia, Australia, Taiwan 2019

Following the cases in China and the increased visibility given to the cases in Cuba, multiple instances of Havana Syndrome occurred throughout the globe in 2019, though many of the specific details have not been disclosed. A senior CIA official with CIA's Europe and Eurasia Mission Center (EEMC)—the same center that Marc Polymeropoulos was in charge of before he retired—was targeted multiple times. The first attack occurred while the CIA official traveled under cover to Poland in the spring of 2019; another incident occurred in Tbilisi, Georgia in the fall of 2019.[143] Separately, two senior-ranking CIA officials traveled to Australia in the fall of 2019 to meet with their intelligence counterparts and while in their hotel room at both locations experienced strong head pressure, ear ringing, dizziness, and nausea.[144] After the Australia trip they traveled to Taiwan to meet with counterparts there and again experienced the same effects when in their hotel rooms.[145] Of particular importance is the fact that one of those officials is reported to be in the top five highest-ranking officials within the CIA, suggesting the attacks were likely meant to send some sort of signal.[146]

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[140] Lederman, "Evacuated After 'Health Attacks' in Cuba and China, Diplomats Face New Ordeals in U.S."

[141] Lederman.

[142] Alex Johnson, "U.S. Evacuates China Consulate Staffers as Illness Mystery Deepens," *NBC News*, June 6, 2018, https://www.nbcnews.com/news/world/u-s-evacuates-china-consulate-staffers-illness-mystery-deepens-n880781.

[143] Ioffe, "The Mystery of the Immaculate Concussion."

[144] Ioffe.

[145] Ioffe.

[146] Ioffe.

6. United Kingdom and United States 2019

In May 2019, a White House staffer working in a London hotel room preparing for then-President Donald Trump's state visit to the United Kingdom experienced a ringing sound that eventually became painful and caused her ears to ring even after she left her room.[147] Later on during the trip, the same staffer invited another staffer to her hotel room, where both experienced the same symptoms. Although the symptoms temporarily subsided after leaving the room, both experienced migraines for the remainder of the trip and continued to suffer from various maladies after the trip's conclusion.[148]

Later in November of 2019, the same White House staffer that was initially targeted in her hotel room in London, was dog-walking with a friend in Northern Virginia when she observed an SUV in front of her house and a man she presumed was following her.[149] "As she stood across from him, she felt an intense pain in her head, which made her double over. She also heard a sharp, high-pitched ringing noise, which was completely different from the sound she had heard in London."[150] Significantly, her friend also heard and felt the sensation, though not as strongly.[151]

7. United States 2020

One year after the suspected attack in Northern Virginia on the White House staffer, a senior National Security Council member walked to his car a few hundred yards away from the Eisenhower Executive Office Building across from the White House and "began to hear a ringing in his ears, his body went numb, and he had trouble controlling the movement of his legs and his fingers."[152] He had difficulty speaking and claimed that

[147] Adam Entous, "Are U.S. Officials Under Silent Attack?," *The New Yorker*, May 24, 2021, https://www.newyorker.com/magazine/2021/05/31/are-us-officials-under-silent-attack.

[148] Entous.

[149] Entous.

[150] Entous.

[151] Entous.

[152] Entous.

within seven minutes he went from feeling fine to believing he might die.[153] He was eventually able to hail a cab and get to the hospital where doctors initially thought he was either on drugs or having a stroke due to his behavior and inability to speak. His speech eventually returned about two hours later.[154] Separately, two White House staffers also reported they were afflicted while walking near the White House in the latter part of 2020.[155]

8. Kyrgyzstan 2020

There were also reports of Havana Syndrome in the Central Asian country of Kyrgyzstan, though it is unclear exactly when in 2020 these instances took place.[156] A U.S. military officer stationed in Kyrgyzstan pulled his car into a busy intersection and began feeling an intense pressure in his head and his two-year old son, who was in the backseat, began screaming.[157] As the officer quickly left the intersection the sensation subsided, and his son stopped screaming.[158] Additionally, a CIA officer from the same location—though with no ties to the military officer—reported a similar incident as well.[159] Significantly, retroactive analysis of cell phone data indicated both victims were located near GRU—Russia's military intelligence service—vehicles when these events happened. While not definitive proof of Russian involvement due to the frequency of Russian intelligence officials following U.S. officials, it is nonetheless strong circumstantial evidence of Russian involvement.[160]

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153 Entous.

154 Entous.

155 Adam Entous, "Vienna Is the New Havana Syndrome Hot Spot," *The New Yorker*, July 16, 2021, https://www.newyorker.com/news/news-desk/vienna-is-the-new-havana-syndrome-hotspot.

156 Dilanian, Lederman, and Kube, "Up to 200 Americans Have Reported Possible 'Havana Syndrome' Symptoms."

157 Entous, "Are U.S. Officials Under Silent Attack?"

158 Entous.

159 Entous.

160 Entous.

9. Austria and Germany 2021

In July of 2021, Adam Entous, a reporter for *The New Yorker* who previously reported on Havana Syndrome, revealed that there were now two dozen suspected cases of Havana Syndrome in Vienna, Austria, which represents the largest number of cases in any country other than Cuba itself.[161] While there are not many public details available, the two-dozen affected are diplomats, intelligence officials, and other government officials who are stationed in Vienna.[162] The historically permissive espionage environment and Cold War significance of Vienna are again another indicator of Russia being behind the Havana Syndrome attacks.[163] A different reported case occurred in Germany, where a diplomat's time in Berlin was cut short due to the effects.[164] Later reporting indicated an additional two U.S. officials in Berlin also sought medical treatment for Havana Syndrome symptoms.[165]

10. Vietnam 2021

About a month after the almost two-dozen cases were reported in Vienna, more cases occurred in Vietnam. On 24 August, Havana Syndrome symptoms were so severe that at least two U.S. diplomats had to be medically evacuated from Hanoi after an attack in their personal residences.[166] Officials acknowledged these are not the first incidents to occur in Vietnam, but earlier investigations were unable to confirm exactly what happened.[167] Significantly, the reports of these cases delayed Vice President Harris' trip

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161 Entous, "Vienna Is the New Havana Syndrome Hot Spot."

162 Entous.

163 Entous.

164 Dilanian, Lederman, and Kube, "Up to 200 Americans Have Reported Possible 'Havana Syndrome' Symptoms."

165 Bojan Pancevski, "U.S. Officials in Germany Hit by Havana Syndrome; Diplomats Affected by Mysterious Symptoms Express Concerns about Vulnerability of American Staff Posted Overseas," *Wall Street Journal (Online)*, August 18, 2021, sec. World, http://www.proquest.com/docview/2562183511/citation/32AE73EB518E49FAPQ/1.

166 Josh Lederman and Andrea Mitchell, "2 U.S. Diplomats to Be Evacuated from Vietnam After 'Havana Syndrome' Incidents," *NBC News*, August 24, 2021, https://www.nbcnews.com/politics/politics-news/two-u-s-diplomats-be-evacuated-vietnam-after-havana-syndrome-n1277539.

167 Lederman and Mitchell.

to Hanoi by several hours, as her delegation waited in Singapore to ensure it was safe for her to continue to Vietnam.[168]

11. India 2021

A few weeks after the high-profile Vietnam case, reports surfaced that a Havana Syndrome case occurred during CIA Director Bill Burns' early September visit to India, requiring a member of his staff to seek medical attention.[169] CNN reported Mr. Burns was "fuming" with anger over the incident, and some within the CIA view the attack as a clear message to the Director that no one is safe from being targeted.[170] The event also raised concerns over U.S. operational security, as the CIA Director's travel schedule is closely guarded.[171]

12. Colombia 2021

Though not reported publicly until mid-October, more than a dozen officials who work at the U.S. Embassy in Bogota, Colombia and their family members reported Havana Syndrome symptoms in mid-September.[172] Though the exact targets are unclear, at least one American is affiliated with intelligence and one victim is a minor.[173] Notably, the Commander of United States Southern Command (USSOUTHCOM), ADM Craig Faller, visited Colombia from 19–21 September, around the time the cases were first reported.[174]

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168 Lederman and Mitchell.

169 Kylie Atwood, "Havana Syndrome: Member of CIA Chief's Team Reported Symptoms on Recent Trip to India," *CNN*, September 21, 2021, https://www.cnn.com/2021/09/20/politics/cia-director-havana-syndrome-india-trip/.

170 Atwood.

171 Atwood.

172 Kylie Atwood, "US Officials Reported Havana Syndrome Symptoms in Colombia," *CNN*, October 12, 2021, https://www.cnn.com/2021/10/12/politics/havana-syndrome-symptoms-colombia/.

173 Vivian Salama, "Havana Syndrome Hits at Least Five U.S. Families Connected to Embassy in Colombia; Bogotá Embassy Is Host to Anti-Narcotics Operatives, Spies, Diplomats, Aid Workers," *Wall Street Journal (Online)*, October 12, 2021, sec. Politics, https://www.proquest.com/docview/2581002863/citation/A5F0119AAC4E43EFPQ/1.

174 Michael Wilner, "'Havana Syndrome' Cases Reported in Colombia Ahead of Visit by SOUTHCOM Commander," *McClatchy Washington Bureau*, October 14, 2021, https://www.mcclatchydc.com/news/nation-world/national/national-security/article254954837.html.

Moreover, the mid-September cases were reported about a week prior to U.S. Secretary of State Antony Blinken's planned visit to Colombia, though his trip continued as scheduled.[175]

Table 1. Havana Syndrome Cases, CAO November 2021

Country	Year	Targets
Cuba	2016-2017	Over 40 DOS and CIA personnel at U.S. Embassy in Havana
Uzbekistan	2017	One USAID officer at Embassy
China	2017-2018	Several U.S. diplomats and trade reps
Russia	2017	CIA Eurasian covert ops chief
Poland	2019	Senior CIA official
Georgia	2019	Same senior CIA official
Australia	2019	Two senior CIA officials
Taiwan	2019	Same two senior CIA officials
United Kingdom	2019	Two White House staffers
United States	2019-2020	White House staffer (2019 same as in UK), two NSC members, two White House staffers
Kyrgyzstan	2020	Military officer and CIA officer
Austria	2021	About two dozen U.S. intelligence officers, diplomats, and other government officials
Germany	2021	Three U.S. diplomats
Vietnam	2021	Two U.S. diplomats
India	2021	One CIA officer on CIA Director's staff
Colombia	2021	Over a dozen U.S. officials and family tied to USEMB in Bogota

B. TECHNOLOGY AND BACKGROUND

While all of these instances of U.S. government employees falling victim to a Havana Syndrome are concerning, it is still unclear just exactly how these attacks are taking place. The NAS report suggests it was some sort of RF weapon, but what is the weapon exactly and who is wielding it? Though this remains unclear, the preponderance of evidence suggests Russia. Indeed, Russia likely has such weapons and has used this form of warfare in the past. Based on detailed analysis of the evidence, it appears Russia is behind these attacks due to the geopolitical ramifications. For one, many of the countries are ones in which Russia retains significant influence and presence. An attack sends a

[175] Nike Ching, "Blinken Accents Democracy, Migration in Visits to Ecuador, Colombia," *VOA*, October 20, 2021, https://www.voanews.com/a/blinken-focuses-on-democracy-migration-while-visiting-ecuador-colombia/6278542.html.

signal to pushback against U.S. efforts in those spaces. Indeed, Cuba, Uzbekistan, Poland, Georgia, Kyrgyzstan, and Austria are all locations where Russia has been active for decades, particularly during the Cold War. While admittedly China, Australia, and Taiwan are outliers in this regard, two possible reasons may account for this: 1) intentional targeting of a high-ranking CIA official in Australia and Taiwan might reflect a target of opportunity for Russia, making the specific location less significant; and 2) additionally, any attempt to poison the relationship between those countries and the United States furthers Russia's goals, and appeared worth the risk. Moreover, Russia has shown a willingness to target its adversaries on foreign soil with unconventional methods, as the brazen 2006 poisoning of Russian defector Alexander Litvinenko and 2018 poisoning of Russian defector Sergei Skripal and his daughter, Yulia, aptly demonstrates.[176] While none of this is conclusive of Russian involvement, Russia nevertheless remains the most likely actor behind Havana Syndrome, especially when accounting for how few countries potentially have the capability and intent to commit such attacks.

One of the strongest evidences that a microwave weapon is suggested is because the symptoms of the victims appear to be consistent with a phenomenon known as the "Frey effect." Back in 1961, Alan Frey discovered that if RF energy with frequencies between 0.4-3 GHz were modulated in a particular way and targeted areas near the ear, then it could produce pressure on the head and a clicking sound in the target.[177] Importantly, this Frey effect can be induced on a target without causing any discernible injury to neural or labyrinthine tissues.[178] In other words, the existence of this Frey effect demonstrates that it is at least technically feasible to use microwave energy to induce symptoms similar to the Havana Syndrome.

Not only is the use of DE waves to induce a neurological response possible, but soon after Alan Frey's work became public the Soviet Union took notice and its Soviet

[176] Gordon Corera, "Salisbury Poisoning: What Did the Attack Mean for the Uk and Russia?," *BBC News*, March 4, 2020, sec. UK, https://www.bbc.com/news/uk-51722301.

[177] National Academies of Sciences, Engineering, and Medicine. 2020, *An Assessment of Illness in U.S. Government Employees and Their Families at Overseas Embassies*, 19.

[178] National Academies of Sciences, Engineering, and Medicine. 2020, 19.

Academy of Science invited him to visit and lecture.[179] After the lecture, he was given tours of various military labs, discussed the neural impacts of microwaves, and was able to view their classified programs.[180] Clearly the Soviet Union was interested in the neurological effects that can be created from RF energy and a now-declassified Defense Intelligence Agency report from 1976 warned these weapons "showed great promise for disrupting the behavior patterns of military or diplomatic personnel."[181] The report also highlighted the large interest the Soviet Union had in this emerging field and that "a significant amount of research continues to be performed in the Eurasian Communist countries to establish the effects of radio waves and microwaves on biological systems," even though that research was not tied to any known weapons program at the time.[182] Nevertheless, the Soviets had been using microwave radiation directed at the U.S. Embassy in Moscow as far back as at least 1953 in an attempt to collect signals or possibly block U.S. communications.[183]

Though it is unclear the exact intent of the use of microwaves targeting the U.S. Embassy in Moscow for decades, one of the earliest cases of possible Havana Syndrome took place in 1996. Two National Security Agency operatives, Mike Beck and Charles Gubete, traveled to a "hostile country" where both men reported feeling groggy and disoriented in their hotel room.[184] While the symptoms passed, ten years later both men developed a rare form of Parkinson's and multiple sources believe these two men may have been a sort of guinea pig for a microwave weapon that appears to be more readily available

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[179] William Broad, "Microwave Weapons Are Prime Suspect in Ills of U.S. Embassy Workers," *The New York Times*, September 1, 2018, https://www.nytimes.com/2018/09/01/science/sonic-attack-cuba-microwave.html.

[180] Broad.

[181] Broad.

[182] U.S. Army Medical Intelligence and Information Agency, "Biological Effects of Electromagnetic Radiation (Radiowaves and Microwaves) Eurasian Communist Countries" (Defense Intelligence Agency, March 1976), https://www.dia.mil/FOIA/FOIA-Electronic-Reading-Room/FOIA-Reading-Room-Nuclear-Biological-and-Chemical/FileId/39946/.

[183] Barton Reppert, "Soviets Resume Bombarding U.S. Embassy With Microwave Beams," *AP NEWS*, March 3, 1988, sec. Archive, https://apnews.com/article/4501cfdc29859dd66ad358221cb83ac8.

[184] "The Mystery of 'Havana Syndrome,'" *The Week*, May 30, 2021, https://theweek.com/politics/1000905/the-mystery-of-havana-syndrome.

and widely used to possibly conduct the attacks that lead to the Havana Syndrome.[185] Why the possible two-decade gap in further employment? It is possible that many more cases have gone unreported, or not publicly confirmed to the press.

One potential reason cases are showing up now is that the technology to conduct microwave attacks has appeared to advance in the last decade. According to Tom Rogan of the *Washington Examiner,* an April 2012 Russian government article claims Russian intelligence services "were mainly engaged in generators that influence the psychophysical state of an individual with their fields and rays" and a 2019 Russian army article mentions the fact that these weapons historically were larger in size but now have become much smaller.[186] The 2019 article documents that "when exposed to low frequency electromagnetic radiation, the human brain releases chemicals that regulate its behavior. They can cause symptoms of various diseases, make a person fall asleep instantly, or, conversely, stay awake for a long time."[187] Moreover, in 2012 Russian President Vladimir Putin reportedly gave the approval for Russian scientists to develop electromagnetic weapons that can attack the central nervous system.[188] Again, all of these descriptions are in line with the current Havana Syndrome cases, and if these weapons exist and have been miniaturized, then they are much easier to employ against U.S. officials.

The difficulty in detecting and countering these miniaturized microwave weapons are exacerbated by likely Russian tradecraft that seeks to mask the true nature of a particular RF signal. According to Eric Haseltine, former head of Research and Development at the National Security Agency, the Russians are likely using a variety of

185 Tom Rogan, "US Intelligence Grapples with Nervous System Attacks Amid Heavy Russia Suspicions," *Washington Examiner*, May 6, 2021, sec. Opinion, https://www.washingtonexaminer.com/opinion/us-intelligence-grapples-nervous-system-attacks-russia.

186 Rogan.

187 Rogan.

188 Christopher Leake and Will Stewart, "Putin Targets Foes with 'Zombie' Gun Which Attack Victims' Central Nervous System," *Daily Mail*, March 31, 2012, https://www.dailymail.co.uk/news/article-2123415/Putin-targets-foes-zombie-gun-attack-victims-central-nervous-system.html.

techniques that would explain the type of energy and method used.[189] This sort of tradecraft is nothing new and harkens back to at least the 1980s, where it took a National Security Agency (NSA) officer, Mike Gandy, over six years to convince the CIA and DOS that he had "identified both the source of electronic espionage in our Moscow embassy and the means by which the Soviet KGB hid that source from our most sophisticated surveillance detection systems."[190] Ultimately, Gandy uncovered over 18 different techniques the Soviets were using to hide the true signals, and it is possible they are doing the same thing with the Havana Syndrome cases.[191]

While it is likely the Russians are employing some sort of microwave device against U.S. officials, there is debate as to whether the intent is to harm officials or simply try to collect intelligence. The use of microwaves to target the U.S. Embassy in Moscow for decades appears to be a case of espionage, as it was less deliberately calibrated to individual people and aimed at the building itself. Though it is certainly plausible that the Havana Syndrome cases are simply espionage cases gone wrong, the increase in frequency of them and the deliberate targeting make a compelling case that the intent is to harm, especially given the descriptions from the aforementioned Russian publications that microwave energy has been weaponized. Bill Evania, a former senior intelligence officer who recently stepped down as the head of the National Counterintelligence and Security Center, believes the cases in Havana were indeed intended to be offensive weapons.[192] James Giordano, who has been frequently cited in this paper as an expert in neurowarfare matters, claims the individuals who have been attacked were not attacked randomly, and have particular career histories that made them targeted.[193] Though that does suggest the targets would be

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189 Eric Haseltine, "Solving the Mystery of Havana Syndrome," *Psychology Today*, June 23, 2021, https://www.psychologytoday.com/ca/blog/long-fuse-big-bang/202106/solving-the-mystery-havana-syndrome.

190 Haseltine.

191 Haseltine.

192 Gordon Corera, "'Havana Syndrome' and the Mystery of the Microwaves," *BBC News*, September 8, 2021, sec. World, https://www.bbc.com/news/world-58396698.

193 Joanna Thompson, "What Are the Mysterious 'Havana Syndrome' Attacks in D.C.?," *HowStuffWorks* (blog), May 27, 2021, https://science.howstuffworks.com/havana-syndrome-attacks-news.htm.

ripe for espionage, something more nefarious seems to be at play. At minimum, government officials are suggesting that even if these cases were attempted espionage, the fact that these devices are known to cause harm means they will likely now be used for harmful purposes.[194]

C. IMPLICATIONS AND CONSEQUENCES OF HAVANA SYNDROME

Havana Syndrome cases have expanded greatly since the initial incidents in Cuba at the end of 2016 and early 2017, and the consequences of these cases, as well as future consequences, are starting to become clear. These consequences range from minor to severe health concerns for officials. Evidence suggests they can effectively neutralize senior officers within the U.S. government, play a role in impacting geopolitical initiatives, and possibly damage intelligence collection efforts. Most alarmingly, since these attacks have proved effective and have not been met with deterrence or a response, they are only likely to increase in the future.

1. Individual Consequences

At minimum there are individual consequences for the targeted officials. Being stationed in an overseas environment is already a challenging situation. The impacts are magnified if physical and psychological effects are felt on the individual and their family members, especially as advanced brain imaging technology is needed to correctly diagnose, a fact that was not known early on during the symptoms. It can also affect the individual's work requirements, which may or may not be passed on to a co-worker. Additionally, the health consequences are often severe and can stay with the member for years, at times even progressively worsening.[195] Furthermore, while there is no official evidence to substantiate this, the potential harm to an area so critical to human cognition—the brain—is likely to impact officials' decision to accept overseas assignments in various countries, especially if doing so also puts their families at risk. So again, at best, this is negatively

[194] Courtney Kube and Carol E. Lee, "As Mystery Over 'Havana Syndrome' Lingers, a New Concern Emerges," *NBC News*, June 9, 2021, https://www.nbcnews.com/politics/national-security/mystery-over-havana-syndrome-lingers-new-concern-emerges-n1270082.

[195] Thompson, "What Are the Mysterious 'Havana Syndrome' Attacks in D.C.?"

impacting U.S. government employees temporarily but also runs the risk of serious long-term harm, demonstrating the urgency in which this issue should be addressed.

2. Operational Consequences

From an operational standpoint, the likely use of microwave weapons to induce Havana Syndrome symptoms is taking U.S. officials off the playing field. The example of Marc Polymeropoulos is a case in point, as the toll of Havana Syndrome ultimately forced him into retirement. This was a senior CIA official, responsible for clandestine operations in fifty countries across Eurasia, during a time period where the United States was starting to shift its national security focus to Russia and China, and with what appears to be a fairly quick attack was able to be permanently sidelined. The United States cannot mass produce CIA officers with almost three decades of experience and losing someone of his caliber ultimately hurts national security. If this is continued in a targeted, deliberate, systematic fashion, serious damages to national security will accumulate as key people in senior leadership positions are no longer willing and/or able to do their jobs.

The other consequences from these attacks are less obvious, but they involve the possible damage to intelligence collection efforts by the United States abroad. Almost half of the known 200 cases at this time are believed to be CIA officers, who are working overseas to cultivate relationships and develop human sources to provide intelligence that will benefit national security. These relationships are personality-based, involving a deep-level of trust and commitment that take time to cultivate. In other words, it is not as simple as the CIA sending new case officers overseas to replace those with Havana Syndrome. The constant rotation of new personnel has the potential to seriously impact human intelligence operations. Additionally, the fact that the CIA seems to be intentionally targeted and the effects of Havana Syndrome can be so severe might serve as a deterrent for potential agents, or foreign information sources, to want to work with the CIA, as they may fear themselves or family members being targeted as well. Human intelligence is already facing its share of challenges in an environment of social media, biometric security, smart cities, and the proliferation of electronic devices, and Havana Syndrome is only going to make it more difficult.

3. Strategic Consequences

There are not only operational consequences, but also strategic consequences for some of these Havana Syndrome attacks, most notably the case of Cuba. Since the Castro regime came to power in Cuba in 1959, the United States has had an adversarial relationship with Cuba but beginning in 2013 the Obama administration took steps to improve that relationship. By early 2016, the U.S. Embassy in Havana had been re-opened and a serious rapprochement between two Cold War foes looked not only possible, but likely. Given this context, the timing of the Havana Syndrome cases is therefore suspicious. In November of 2016 there was not only the election of Donald Trump—who did not agree with this new approach to Cuba—but also the death of Fidel Castro, who though he stepped down as the President of Cuba in 2008, was still the largest figure in Cuban politics. The fact that the attacks occurred right around this time might be a coincidence but it's not unreasonable to think that Russia might have carried them out as a way to torpedo the warming of ties between the United States and Cuba. Even if that wasn't what was intended, it does not detract from the fact that the Havana Syndrome attacks *did* contribute to the cooling of ties between the countries and the serious scale-back of personnel at the U.S. Embassy. In other words, whether it was intended or not, the Cuba example demonstrates just how much of an impact these cases can have on U.S. interests.

Compounding the significant consequences of these attacks is the difficulty in knowing if and how the United States should respond. There is not only the problem of attribution—which the United States has not stated as of this writing—but also the right level of response. Even if the United States could definitively identify Russia as culpable, the appropriate response is unclear. Should the United States consider this an act of aggression or war? Should it take military action, impose sanctions, or respond through some sort of gray zone or covert action? The dilemma that Havana Syndrome creates is substantial, especially since it has shown it can create strategic effects for an adversary, which is indicative of the complicated challenge neurowarfare poses in general.

The next chapter provides an overview of the current strategic context, including the United States' two main competitors, and explains why that context is likely to lead to the further development of neurowarfare.

IV. STRATEGIC CONTEXT

> The target of all human conflict, the battleground of all conflict resolution, is the human mind. In reframing all conflict as one form of warfare or another, neocortical warfare rejects the notion that warfare is an aberration. It accepts that conflict will never end and that we must invest resources to win its endless engagements.
>
> —Colonel Richard Szafranski, USAF, 1994[196]

In order to better understand the neurowarfare activities currently underway, one must first appreciate the security landscape, understand the motives of the actors, and highlight how adversaries are trying to upend the status quo through irregular methods. With this understanding, neurowarfare and its implications begin to make strategic sense, especially as it relates to influence, manipulation, and control, which is the essence of GPC.

A. CURRENT SECURITY ENVIRONMENT

The current international security environment is defined by great powers vying for influence in numerous countries and regions of the world as they seek supremacy in global affairs. Top-level strategy documents such as the 2017 National Security Strategy (NSS) and 2018 National Defense Strategy (NDS) highlight the return to GPC, as if there ever was a time in international relations when GPC wasn't occurring. Nonetheless, the United States has undoubtedly entered into an era of geopolitical struggle against peer and near-peer adversaries of China and Russia—along with regional adversaries of North Korea and Iran while also continuing to engage non-state transnational threat actors—that is likely to shape the next several decades of stability and conflict. At the heart of it, GPC is a contest for access and influence.

In order to gain this influence, states must employ and synchronize the full range of instruments of power (IOPs)—Diplomatic, Information, Military, and Economic

196 Richard Szafranski, "Neocortical Warfare? The Acme of Skill," *Military Review*, November 1994, 51.

(DIME) to name a few, but also Financial, Intelligence, Legal IOPs, and more. However, similar to the ideological battles of the Cold War, the competition space between an American-led world order and a Chinese or Russian-led one is likely to play out on the periphery both in terms of locations and methods more than conventional, direct, state-on-state military conflict.

As evidence to support this assessment of the current strategic environment, numerous U.S. strategic documents echo these claims. The 2017 NSS aptly describes the nature of the struggle that the United States is in with its competitors, and the differences in values between these competing worldviews:

> China and Russia challenge American power, influence, and interests, attempting to erode American security and prosperity. They are determined to make economies less free and less fair, to grow their militaries, and to control information and data to repress their societies and expand their influence. At the same time, the dictatorships of the Democratic People's Republic of Korea and the Islamic Republic of Iran are determined to destabilize regions, threaten Americans and our allies, and brutalize their own people. Transnational threat groups, from jihadist terrorists to transnational criminal organizations, are actively trying to harm Americans. While these challenges differ in nature and magnitude, they are fundamentally contests between those who value human dignity and freedom and those who oppress individuals and enforce uniformity.[197]

The NSS continues to broadly discuss how our competitors are choosing to confront the United States. First, they are directly countering American military strength, investing in niche capabilities that neutralize U.S. power in all domains. Second, and more disturbing, competitors are expanding the competitive space away from military capability and capacity, which they temporarily cede to American military might, and engaging in nontraditional ways, with a long-term view of the struggle:

> Adversaries studied the America way of war and began investing in capabilities that targeted our strengths and sought to exploit perceived weaknesses. The spread of accurate and inexpensive weapons and the use of cyber tools have allowed state and non-state competitors to harm the United States across various domains. Such capabilities contest what was

[197] White House, *National Security Strategy of the United States of America* (Washington, DC: White House, 2017), 2–3, https://trumpwhitehouse.archives.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf.

> until recently U.S. dominance across the land, air, maritime, space, and cyberspace domains… In addition, adversaries and competitors became adept at operating below the threshold of open military conflict and at the edges of international law. Repressive, closed states and organizations, although brittle in many ways, are often more agile and faster at integrating economic, military, and especially informational means to achieve their goals. They are unencumbered by truth, by the rules and protections of privacy inherent in democracies, and by the law of armed conflict. They employ sophisticated political, economic, and military campaigns that combine discrete actions. They are patient and content to accrue strategic gains over time—making it harder for the United States and our allies to respond. Such actions are calculated to achieve maximum effect without provoking a direct military response from the United States. And as these incremental gains are realized, over time, a new status quo emerges.[198]

The 2018 NDS acknowledges this strategic environment, and further illuminates how our competitors are pursuing their goal of disrupting the status quo by taking advantage of obscurity and opaqueness:

> Both revisionist powers and rogue regimes are competing across all dimensions of power. They have increased efforts short of armed conflict by expanding coercion to new fronts, violating principles of sovereignty, exploiting ambiguity, and deliberately blurring the lines between civil and military goals.[199]

Adversaries are able to leverage their grip on power to transform and react faster than the United States, especially over the past three decades as the United States has shifted focus post-Cold War towards non-state actors and been preoccupied with the challenges in Afghanistan and Iraq. The United States has struggled with responding to this type of challenge for several reasons, but mainly due to cultural and moral reservations. The United States fundamentally believes in the rule of law and being transparent, for democracies require it to maintain political power in a way that authoritarian regimes do not.

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198 White House, 27–28.

199 Department of Defense, *Summary of the 2018 National Defense Strategy of the United States of America* (Washington, DC: Department of Defense, 2018), 2, https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf.

B. IMPLICATIONS OF GRAY ZONE ACTIONS

With a better understanding of "what" our strategic competitors are doing, we can begin to discuss the implications. Numerous scholars have attempted to define this "new" form of competition that blurs and blends the boundaries below the level of armed conflict, with terms like "*Gray Zone*," "*Hybrid Warfare*," "*Asymmetrical Warfare*," and more. Dr. Kathleen Hicks, the current Deputy Secretary of Defense (DepSecDef), has called this style the gray zone in describing how this plays out in practice:

> The United States is being confronted with the liabilities of its strength. Competitors are contesting the rules of the international system and U.S. leadership. With the significant costs of engaging the Unites States in combat, and the growing range of indirect and non-military tools at their disposal, rivals are finding avenues for threatening U.S. interests without triggering escalation. Their coercive tools range the spectrum of fake news and online troll farms to terrorist financing and paramilitary provocations. Such approaches lie in the contested arena somewhere between routine statecraft and open warfare—the "gray zone."[200]

Strategist Hal Brands defines the gray zone as an "activity that is coercive and aggressive in nature, but that is deliberately designed to remain below the threshold of conventional military conflict and open interstate war."[201] He describes a core element of the gray zone as being vague in nature and unconventional in tactics. This, of course, leads to confusion and disagreement in how to respond that U.S. adversaries are eager to exploit.

Dr. Michael Mazarr describes these actions as "maneuver[ing] in the ambiguous no-man's-land between peace and war, reflecting the sort of aggressive, persistent, determined campaigns characteristic of warfare but without the overt use of military force."[202] Basically, as has always happened in the international system, states (or depending on different eras in history—tribes, city-states, or other entities of interaction)

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[200] Kathleen H. Hicks and Alice Hunt Friend, *By Other Means Part I: Campaigning in the Gray Zone*, CSIS Reports (Lanham: Center for Strategic & International Studies, 2019), v.

[201] Hal Brands, "Paradoxes of the Gray Zone," *Foreign Policy Research Institute*, February 2016, https://www.fpri.org/article/2016/02/paradoxes-gray-zone/.

[202] Michael J. Mazarr, *Mastering the Gray Zone: Understanding a Changing Era of Conflict* (Carlisle Barracks, PA: United States Army War College Press, 2015), 2, https://publications.armywarcollege.edu/pubs/2372.pdf.

will always compete with each other in an attempt to gain the upper hand in order to further their national interests of peace, prosperity, and security for their people. Mazarr correctly highlights that these strategies are as old as time: "States have been using these kinds of approaches for centuries, in some ways for millennia. Concepts such as political destabilization, support for proxies and militias, information campaigns, and much more have been a staple of statecraft since the city states of ancient Greece were vying for influence."[203]

C. COMPETITORS' FOREIGN POLICY GOALS, STRATEGIES, AND EXAMPLES

In order to provide more specific context for the current strategic environment, consider how China and Russia view themselves, what their foreign policy aims are, and how they are accomplishing this strategy in practice. DepSecDef Hicks has categorized seven primary tools that China and Russia use in their arsenals to further their ends: 1) information operations and disinformation; 2) political coercion; 3) economic coercion; 4) cyber operations; 5) space operations; 6) proxy support; and 7) provocation by state-controlled forces.[204] A comprehensive discussion of all these tools is outside the scope of this paper. Rather, we provide high-level examples that illustrate how China and Russia are exercising their power in practice.

1. China

China sees itself as a rising power that, after a century of humiliation and exploitation by outside powers, is now re-taking its rightful place atop the international system. The Chinese Communist Party (CCP), led by General Secretary and President Xi Jinping in its one-party system, intends for China to be a regional, and eventually global, hegemon by leveraging and synchronizing all of its instruments of power to increase its influence. It does this by emphasizing non-military means and gray zone activities to disrupt the status quo. For example, the CCP has consistently infringed on smaller states'

[203] Mazarr, 3.

[204] Hicks and Friend, *By Other Means Part I*, v.

fishing waters, claiming it as their own and depriving local fishermen of their very livelihood. The CCP has repeatedly breached the territorial integrity of the Senkaku Islands—often using fishermen to conceal Beijing's direct involvement—which Japan has claimed as their own for years.[205] It has dredged, built, occupied, and militarized island chains in the South China Sea.[206] The CCP has increasingly exercised territorial control in the East China Sea by bullying and intimidating any challengers, especially with economic coercion, but also through the establishment of Air Defense Identification Zones (ADIZ) to aggressively assert sovereignty claims and further their interests and influence in the region.[207]

China's Belt and Road (BRI) initiative is their large-scale infrastructure strategy that ultimately results in economic coercion and global access. It accomplishes this by convincing weaker countries to take on massive debt to build infrastructure projects conducive to China's ends, knowing they may be unable to pay and will therefore remain indebted to China. The BRI also includes a "digital Silk Road" that calls for expanding its influence and control over the information domain through restricting and censoring internet traffic.[208] The CCP recognized the trends of digitalization and importance of information in modern society, and has invested heavily in key telecommunications companies like ZTE and Huawei, concluding that if it can control the information highways of the future, the information will be more readily accessible and manipulable towards the CCP's ends.[209]

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[205] Jonathan W. Greenert, "Murky Waters in the East China Sea: Chinese Gray-Zone Operations and U.S.-Japan Alliance Coordination" (The National Bureau of Asian Research, May 2021), 6, https://www.nbr.org/wp-content/uploads/pdfs/publications/sr90_murkywaters_may2021.pdf.

[206] David Geaney, "China's Island Fortifications Are a Challenge to International Norms," *Defense News*, April 17, 2020, sec. Commentary, https://www.defensenews.com/opinion/commentary/2020/04/17/chinas-island-fortifications-are-a-challenge-to-international-norms/.

[207] Michael Green et al., "Counter-Coercion Series: East China Sea Air Defense Identification Zone," Countering Coercion in Maritime Asia: The Theory and Practice of Gray Zone Deterrence (CSIS, June 13, 2017), https://amti.csis.org/counter-co-east-china-sea-adiz/.

[208] Adrian Shahbaz, "Freedom on the Net 2018: The Rise of Digital Authoritarianism" (Freedom House, 2018), https://freedomhouse.org/report/freedom-net/2018/rise-digital-authoritarianism.

[209] Dean Cheng, *Cyber Dragon: Inside China's Information Warfare and Cyber Operations*, Changing Face of War (Santa Barbara, California: Praeger, an imprint of ABC-CLIO, LLC, 2017), 7–11.

The CCP's control also manifests in the surveillance and censorship it exercises on its own domestic population, referred to as "The Great Firewall."[210] Moreover, the CCP is selling repression technology to other authoritarian regimes, including facial-recognition software and data-analytics tools, to sift through big data in an effort to convert into usable information that controls populations, both domestic and foreign.[211] To date, the CCP has tied this control of data to compliance by implementing the "Social Credit System" (SCS) in order "to centralize data platforms into a big data-enabled surveillance infrastructure to manage, monitor, and predict trustworthiness of citizens, firms, organizations, and governments in China."[212] The score from the SCS is used as punishment or reward to allow citizens and organizations to access not only government provided systems, but any public institutions in an attempt to further control of their own population.[213] It is clear the CCP recognizes the value of controlling the flow of information into and out of its territory as a means of controlling the population. The CCP has also traditionally relied on a strategy of cyber espionage in order to reach its strategic goals, stealing valuable intellectual property R&D in order to quickly gain ground on military and commercial technology.[214] As will be discussed in Chapter V, this model of investing in new technologies as a way to shape populations and maintain control is indicative of their approach to neuro S&T.

2. Russia

Historically, Russia views itself as a great power that does not receive the level of respect it believes it deserves from the West and is weary of Western intentions toward it. As such, Russia has spent the last two decades under President Vladimir Putin attempting to reemerge as a great power after its defeat in the Cold War by increasing its influence on the global stage to gain back its former prestige. Russia often uses irregular methods to

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210 Tim Maurer, *Cyber Mercenaries: The State, Hackers, and Power* (Cambridge New York, NY Port Melbourne New Delhi Singapore: Cambridge University Press, 2018), 61–64.

211 Shahbaz, "Freedom on the Net 2018: The Rise of Digital Authoritarianism."

212 Fan Liang et al., "Constructing a Data-Driven Society: China's Social Credit System as a State Surveillance Infrastructure," *Policy & Internet* 10, no. 4 (2018): 415–53.

213 Liang et al.

214 Andrea Gilli and Mauro Gilli, "Why China Has Not Caught Up Yet," *International Security* 43, no. 3 (Winter 2018): 141.

combat the lack of conventional military parity with the West, including but not limited to espionage, cyber, and information operations.[215] Russia used disinformation and proxy groups to annex Crimea and create a frozen conflict in Eastern Ukraine. For decades, it has attempted to influence U.S. elections, and Russia's GRU routinely probes the U.S. power grid for weaknesses. Russia also makes use of a private military contracting group—the Wagner Group—as a proxy organization to further its ends in various places such as Syria, Libya, and Venezuela in order to obfuscate the Kremlin's role in these countries.[216] Finally, Russia also cheated using performance enhancing drugs on Olympic athletes in order to gain international standing, leading to a formal country ban during the Tokyo Olympics in the summer of 2021.[217]

Russia also employs economic coercion in the form of withholding its vast natural gas supplies to Ukraine and Western European countries—typically during the coldest seasons when natural gas is in most demand. It used cyber to devastating effect against Estonia in 2007, often employing so-called "patriot hackers" with no obvious ties to the government. While it did conduct a conventional invasion of Georgia in 2008, it did so under the dubious pretense it was protecting Russian citizens after issuing passports to residents of the breakaway provinces of Abkhazia and South Ossetia.

The overarching purpose of this section was to describe and interpret the foreign policy goals and irregular methods China and Russia currently use in synchronized fashion to weaken and undermine the U.S.-led international world order through nonmilitary ways in order to restore status and influence for these once great powers. It is far from exhaustive, but rather serves to provide a small sampling of actions and intentions. As the next section will show, these states' use of irregular tactics to further upend the status quo is continued in neurowarfare.

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[215] Gabriel Lloyd, "Hybrid Warfare and Active Measures," *Small Wars Journal*, October 10, 2021, https://smallwarsjournal.com/jrnl/art/hybrid-warfare-and-active-measures.

[216] Andras Rácz, "Band of Brothers: The Wagner Group and the Russian State," *Center for Strategic and International Studies* (blog), September 21, 2020, https://www.csis.org/blogs/post-soviet-post/band-brothers-wagner-group-and-russian-state.

[217] Tariq Panja, "Russia Banned From Olympics and Global Sports for 4 Years Over Doping," *The New York Times*, December 9, 2019, sec. Sports, https://www.nytimes.com/2019/12/09/sports/russia-doping-ban.html.

D. NEUROWARFARE AS A NEW STRATEGIC TOOL

Consider again Dr. Hicks list of seven tools of employment. The authors suggest adding an eighth that has just recently arisen but is the purpose of this thesis as it has rapidly grown in frequency, intensity, and effectiveness: 8) neurowarfare. The authors argue U.S. adversaries have just adapted scientific achievements into new ways, new tools, new tactics, and new strategies in a new domain—one that directly targets the brain—*neurowarfare*, but that as of now has purposely been non-lethal in order to prevent escalation. How have they done this?

Dr. John Arquilla, distinguished professor at the Naval Postgraduate School, prescribes exactly how a U.S. adversary may seek such an asymmetrical approach to counter American might: "These modes of conflict are generally reflected by instances in which a nation chooses to counter or confront a potential adversary by investing in off-design technologies and highly innovative concepts of operations, rather than by imitating the structure and doctrine of the opposing forces."[218] This appears to fit the mold of how neurowar is playing out in real time. In describing these gray zone activities, Arquilla argues that too much focus on a new term is wrong-headed and creates confusion, preventing the United States from properly engaging and waging in the competition continuum in all its various forms and tactics.[219] Whatever the correct, agreed-upon doctrinal term, our present-day adversaries are employing these tactics of low-level, perpetual, indirect, and irregular war using all available tools. But why would they do this?

There are multiple reasons, but the biggest is cost. The United States still has the largest economy and spends more on defense than any of its adversaries (though not as much as when purchasing power parity is considered). As previously mentioned, currently, China and Russia are willing to cede military primacy in part because their ends are regional in nature. At least for the time being. However, they have pivoted to other methods, particularly in space and cyberspace. As the cost of both preparing for and waging

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[218] John Arquilla, "Perils of the Gray Zone Paradigms Lost, Paradoxes Regained," *Prism* 7, no. 3 (2018): 122.

[219] Department of Defense, *Competition Continuum*, Joint Doctrine Note 1–19 (Washington, DC: Department of Defense, 2019), v.

conventional war increases in an era of globalization defined by economic, social, and cultural interdependencies, the primary method of aggression and destabilization has shifted from pursuing physical destruction and violence to influencing and controlling large populations.[220] In essence, authoritarian regimes could both control their own populations while undermining democratic nations. This involves a shift in higher-level strategy to more political ends rather than military means, but it is certainly not new.

Sun Tzu, the Chinese military strategist living in 500 BC famously wrote, "Hence to fight and conquer in all your battles is not supreme excellence; supreme excellence consists in breaking the enemy's resistance without fighting."[221] While conventional military capabilities are still needed and provide value for deterrence, coercion, and crisis management purposes, the probability of long-lasting, intense, state-on-state conflict is decreasing, especially as nuclear-armed foes try to prevent escalation to the use of nuclear weapons. Furthermore, adversaries have learned it is cheaper and easier to slowly erode away U.S. power and influence, playing the long game rather than a direct "clash of civilizations," as happened in World War II and the Cold War. Neurowar, while having many military applications, can actually be of greater use in manipulating, controlling, and undermining societies writ large.

The main conventional weapons of today—including the fighter jet, aircraft carrier, and tank—seem particularly ill-suited for the future of conflict. Martin Van Creveld predicted such a shift decades ago in his 1991 book, *The Transformation of War*.[222] Due to the rapid proliferation and dissemination of information across the globe, which shapes narratives and global opinion, strategies that use non-kinetic and non-lethal means will increase in value moving forward. This has put an increasing emphasis on the information domain and the contest for information that can manipulate beliefs. In essence, adversaries are exploiting the inherent weaknesses of democratic political systems which require openness, transparency, and accountability to shape the environment. Indeed, information

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220 Krishnan, *Military Neuroscience and the Coming Age of Neurowarfare*, 139.

221 Sun Tzu and James Clavell, *The Art of War* (New York: Delacorte Press, 1983), 20.

222 Martin Van Creveld, *The Transformation of War* (New York : Toronto : New York: Free Press ; Collier Macmillan Canada ; Maxwell Macmillan International, 1991).

warfare (IW) is becoming more important in an interconnected and globalized world to gaining influence, and countries such as Russia and China utilize IW with great effect.

E. IMPLICATIONS FOR GPC

While countries' use of IW is gaining prominence as a major tool to gain influence in the world, neurowarfare seems to fit nicely into this archetype. Armin Krishnan sums up the stakes: "Ultimately, there is no higher valuation in war than subversion of the enemy's mind. If this can be achieved through targeting the enemy's brain directly, it would be the most powerful weapon that has ever been devised by humanity."[223] Science is pushing the boundaries of the realm of the possible to do more than influence narratives and shape global opinion, but rather to *control*. Spurred on by rapid technological advances in neuro S&T, states are employing new means and methods to shape, influence, and control events by directly targeting the human brain. Neuro S&T has enormous relevance for future conflicts in this era of GPC.[224] In many ways this is an entirely new domain of warfare, but it also serves as the center of gravity for every other domain as all human cognition happens within the brain, and therefore every action within every other domain is first conceived, constructed, and enacted within the human brain. The implications of the weaponization of neuro S&T, or neurowarfare, are profound from a national security standpoint due to the potential potency of the weapons, difficulty in detection, and ease with which they can be employed to influence and control people.

F. PHILOSOPHICAL ORIGINS OF NEUROWAR AND RELATIONS TO PSYCHOLOGICAL WARFARE

This natural evolution from IW to direct manipulation has been building for decades. In fact, a similar thesis was put forward in 1994 by then-Colonel Richard Szafranski, USAF. Coining the term "neocortical warfare," Szafranski's thoughts act as a precursor with the aim of attacking the enemy's will to the current concept of neurowarfare:

> The object of war is, quite simply, to force or encourage the enemy to make what you assert is a better choice, or to choose what you desire the enemy

[223] Krishnan, "Attack on the Brain: Neurowars and Neurowarfare," 20.

[224] Krishnan, *Military Neuroscience and the Coming Age of Neurowarfare*, 139.

> to choose. Said another way, the object of war is to subdue the hostile will of the enemy. We cannot meet the immediate objective of war until or unless we subdue hostile will…if weapons are means used to coerce an adversary's will, then even our understanding of weapons must go beyond things, implements or tools. Yet, we have concentrated our attention on the concrete means and material ways used to subdue hostile will's host, rather than on the nature of will itself.[225]

Szafranski laid the intellectual framework that targeting an adversary's brain to manipulate its behavior will likely prove to be a more effective mechanism for accomplishing military objectives than the use of physical violence.[226] Moreover, he concluded that not only will this neocortical warfare be prevalent in the future, but its complexity will make it the most demanding, stressing the need for strategic thinkers to develop a theory for how best to employ it.[227]

Szafranski was ahead of his time scientifically and technologically, but his thinking has been prophetic. He sought a broader meaning to Prussian military strategist Carl von Clausewitz's definition of war as "thus an act of force to compel our enemy to do our will" by employing the maximum use of force through the maximum exertion of strength.[228] Szafranski asks, "What if we viewed war not as the application of physical force, but as the quest for metaphysical control?"[229] He thus defines neocortical warfare: "Neocortical warfare is warfare that strives to control or shape the behavior of enemy organisms, but without destroying the organisms. It does this by influencing, even to the point of regulating, the consciousness, perceptions and will of the adversary's leadership: the enemy's neocortical system."[230] This concept is revolutionary, but a quick search of the term in the literature shows it never caught on or became widely diffused. Instead, most

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225 Szafranski, "Neocortical Warfare? The Acme of Skill," 42.

226 Szafranski, 47.

227 Szafranski, 54.

228 Carl von Clausewitz, Michael Howard, and Peter Paret, *On War* (Princeton, N.J: Princeton University Press, 1976), 75–77.

229 Szafranski, "Neocortical Warfare? The Acme of Skill," 43.

230 Szafranski, 47.

think of this concept as the realm of psychological warfare since the emphasis is on *influence,* although with clear limitations.

The premise behind psychological warfare is "the planned tactical use of propaganda, threats, and other non-combat techniques during wars, threats of war, or periods of geopolitical unrest to mislead, intimidate, demoralize, or otherwise influence the thinking or behavior of an enemy."[231] Early PSYOP pioneers correctly intimated "that wars are fought and won or lost not on battlefields but in the minds of men."[232] Neurowarfare overlaps with this intent, but differs in the means of accomplishing its goals. There is a clear distinction between psychological warfare and neurowarfare in the method of influence; PSYOPs are limited to communications to influence, whereas neurowarfare involves directly targeting the brain through physical manipulation. The beginnings of that technology is here now, and it's likely to continue to develop over the next several decades.

Dr. Armin Krishnan has expanded Szafranski's "neocortical warfare" concept to develop a comprehensive look at the various applications of neurowarfare. Indeed, he has not been shy in discussing the implications to completely revolutionize warfare, along with the state and society. He boldly asserts "neuroscience will lead to the development of 'neuroweapons,' which can remotely manipulate mental states, emotions, perceptions, thinking, and behavior of adversaries."[233] He contends one of the benefits of this form of warfare is it is "culturally agnostic;" meaning, since it targets the brain, neuroweapons do not need to be tailored to a particular cultural context.[234] He also lays out the scope in which neurowarfare can be conducted, from altering the values and beliefs of a particular country, to destabilizing a country through fear, or to targeting a country's political leaders,

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231 Robert Longley, "An Introduction to Psychological Warfare," *ThoughtCo*, October 22, 2019, sec. ThoughtCo, https://www.thoughtco.com/psychological-warfare-definition-4151867.

232 Paul E. Valley and Michael A. Aquino, "From PSYOP to MindWar: The Psychology of Victory," *Headquarters, 7th Psychological Operations Group*, 1980, 6, https://samim.io/dl/From-PSYOP-to-MindWar-The-Psychology-of-Victory-Position-Paper-by-US-Colonel-Paul-E-Valley-and-Major-Michael-A-Aquino.pdf.

233 Krishnan, "Attack on the Brain: Neurowars and Neurowarfare," 4.

234 Krishnan, 16.

often without any awareness from a country that this targeting took place.[235] The effects of this form of warfare is the potential "take down of a strategic competitor permanently without nuclear war and the risk of devastating nuclear attack."[236] Such a goal seems to align with both Chinese and Russian intent towards American hegemony.

G. HISTORICAL ROLE OF TECHNOLOGY IN GPC

As history can attest, a big factor in determining whether nations can stay dominant in the international relations system depends on continued technology development. In our current era, that means the fate of the United States and the Western liberal, rules-based world order it has championed for the past seventy-five years will depend specifically on technology development in the realm of neuro S&T as much as it does on nuclear, space, and cyber realms. Throughout the course of history, there has been a continual search for new and better weapons as technological frontiers unlock new areas of discovery and potential. However, "the enemy also gets a vote." As new weapon systems are generated and operationalized, the enemy finds ways to counter in the form of better defensive systems or stronger deterrent methods, which inevitably either counteract, counterbalance, or supersede the previous weapon system. The quest for a superweapon, that which has no defenses or deterrents, continues.[237] Will neuroweapons end this search? More surgical than nukes, but more strategic than pure destruction, neuroweapons have unparalleled potential.

H. NEUROWAR COMPARISON TO CYBERWAR

In many ways, we are at a similar time in the technology development of neurowarfare as when Dr. Arquilla and Dr. Ronfeldt highlighted cyberwar in 1993 by publishing their prescient article titled, "Cyberwar is Coming!" about the impending nature of society, and subsequently warfare, to depend on the cyber/information domain as a pillar

235 Krishnan, 17–18.

236 Krishnan, 17–18.

237 Giordano, *Neurotechnology in National Security and Defense*, 116.

for all other activities.[238] Though neuro S&T is still an emerging field with many unknowns, there is enough evidence to suggest neurowarfare is likely to become not just an important form of warfare, but *the last and most important domain of warfare* as it has the potential to dominate the future of conflict for the rest of human history. As stated by Krishnan, "This creates both humanitarian opportunities in making war less bloody and burdensome as well as some unprecedented threats and dangers in terms of preserving freedom of thought and will usher in a coming age where minds can be manipulated with great precision."[239]

The possibilities and potential use-cases for neurowarfare are almost endless and will obviously depend on the technologies created. But many questions remain relating to authorities, targeting, employment, and deterrence. Just like cyber warfare, neurowarfare could be waged defensively or offensively. In a defensive capacity, neurowarfare could prevent conflict before it starts, changing attitudes and perceptions about the potential adversary, thus easing tensions.[240] Utility could be applied to unconventional warfare and resistance movements, whether military or political in nature. In an offensive capacity, neurowarfare could "manipulate the political and social situation in another state," thus destabilizing the adversary, either as a stand-alone tactic or in conjunction with a military strike.[241] Again, the possibilities are numerous.

I. CONCLUSION

This chapter has discussed the enduring struggle between states in the international system but updated to include the current adversaries and methods. In an era of interconnectedness, there is great value to unconventional and irregular methods that use information rather than physical destruction to manipulate beliefs. Neurowarfare appears to be an extension of this strategy, seeking to influence, manipulate, and ultimately control individuals and populations. This is achieved by investing in new neuro technologies that

238 Arquilla and Ronfeldt, "Cyberwar Is Coming!"

239 Krishnan, *Military Neuroscience and the Coming Age of Neurowarfare*, i.

240 Krishnan, "Attack on the Brain: Neurowars and Neurowarfare," 17.

241 Krishnan, 17.

impair individuals and create strategic dilemmas in a non-lethal fashion, thus precluding escalation. The intellectual underpinnings are not new, as the basic concepts have been discussed for decades with slightly different terminology, from psychological warfare to neocortical warfare. As the title of this thesis suggests, there are direct parallels with neurowarfare to how cyberwar was viewed in the 1990s, before it became a critical element of military capability and society writ large.

The next chapter provides a deeper dive into the collective perspective of China and Russia in the area of neurowarfare. Giordano has summed up the high stakes of neurowar, stating, "the brain is the next battlespace."[242]

[242] Requarth, "This Is Your Brain. This Is Your Brain as a Weapon."

V. CHINA AND RUSSIA NEUROWARFARE MINDSET

> Cognitive domain operations have already become the main battlefield for other countries conducting ideological penetration, and is an important domain for both sides in a war to fight for or destroy troop morale and cohesion, as well as forming or deconstructing operational capabilities.
>
> —Luo Yuzhen, Chinese National University of Defense Technology Researcher, 2018[243]

> The reason is armed struggle is steadily getting more complex, there is synergy between military and nonmilitary confrontation means, and lots of other factors. There are new spheres (continuums) of military confrontation: information-communication, consciental (psychological), and cognitive (area of thinking). Before long, new types of weapons will appear and, therefore, also new spheres of struggle (that are not much in evidence or are only forecasted).
>
> —Lt. Col. V. I. Yakupov, Russian Military Strategist, 2017[244]

As discussed in Chapter IV, China and Russia are the two most significant strategic competitors of the United States, with China having the greater potential of challenging U.S. leadership. This thesis has sought to demonstrate that neurowarfare is an emerging variation of irregular warfare that has the potential to radically change the way wars are fought. In response, there is a natural follow-on question that must be addressed: "How do these two states view neurowarfare?" This chapter seeks to answer that question by discussing the strategic thinking, neurotechnology sectors, and military concepts around neurowarfare of both countries. It will conclude with a comparison of the two states, arguing Russia is the

243 Nathan Beauchamp-Mustafaga, "Cognitive Domain Operations: The PLA's New Holistic Concept for Influence Operations," *Jamestown Foundation*, China Brief, 19, no. 16 (September 6, 2019), https://jamestown.org/program/cognitive-domain-operations-the-plas-new-holistic-concept-for-influence-operations/.

244 Timothy L. Thomas, "Russian Forecasts of Future War," *Military Review*, June 2019, 86, https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/May-June-2019/Thomas-Russian-Forecast/.

more significant near-term danger but China is the more concerning long-term threat in this domain. Overall, both countries possess capability in this field, are actively seeking advancements, and believe in the theoretical potential of neurowarfare, which should serve as a warning flag to the United States about the seriousness of the threat.

A. CHINA

The following section refers to China and the Chinese Communist Party.

1. Ideological Origins of Influence and Control

For much of its 100-year history, the CCP has placed great emphasis on controlling people's behavior through influencing the way individuals think and dictating to them what to believe. This has generally taken the form of total control over information combined with propaganda and indoctrination measures that attempt to shape attitudes and beliefs of individuals. One example of this is in the introduction to a book on Mao Zedong's collected works published in 1944 by Deng Tuo, one of China's most prominent propagandists, where Tuo writes "historical practice has fully demonstrated that Comrade Mao Zedong's thought is the only correct thought," demonstrating an intolerance of dissenting views.[245] Even prior to this, in 1941 a senior CCP military commander described the importance of having people's "minds washed out" which "had to be remolded in ideology" generally over the course of the year before they could become active members in the CCP.[246]

Soon after the CCP won the Chinese Civil War and established the People's Republic of China on October 1st, 1949, these sorts of indoctrination efforts not only continued, but intensified as the party sought to maintain their grip on power. American journalist Edward Hunter—often credited with coining the term "brain washing"—wrote an article (and later a book on the subject) in September 1950 entitled *Brain-washing Tactics Force Chinese Into Ranks of Communist Party*, where he argued CCP techniques turned average Chinese people

[245] Aris Teon, "Brainwashing the People – Mao Zedong, the Chinese Communist Party and the Politics of Thought Control," *The Greater China Journal* (blog), March 10, 2019, https://china-journal.org/2019/03/10/brainwashing-the-people-mao-zedong-the-chinese-communist-party-and-the-politics-of-thought-control/.

[246] Miles Maochun Yu, "Beijing's Woke Propaganda War in America," *Hoover Institution*, May 5, 2021, https://www.hoover.org/research/beijings-woke-propaganda-war-america.

into mindless automations.[247] While some of Hunter's claims were later found to be a bit exaggerated—since there was no evidence that individuals completely lost their free agency despite being highly coerced—he nevertheless documented the importance the CCP placed on trying to control how people think, as well as the CCP's relative success in doing so.[248]

The CCP's desire to coerce behavior and manipulate the mind has continued throughout the decades of its rule, whether it's through the use of reeducation camps, Maoist Struggle Sessions, the Chinese Cultural Revolution, or a blackout of information concerning the infamous Tiananmen Square massacre in June 1989. These efforts to influence the human mind are ongoing with China's Great Fire Wall, blocking any information the CCP deems harmful to its rule, as well as the establishment of prison camps for Uighur Muslims, where the CCP attempts to indoctrinate and "reeducate" those it believes do not hold correct views and pose a threat to the state.[249] China also has an extensive propaganda campaign to not only bolster CCP legitimacy in China but also to influence and coerce other countries' behavior—most notably the United States.[250]

It's clear from the CCP's history through today that China believes influencing thought and behavior is of the utmost importance, something that could be enhanced greatly through the use of neuro S&T. Indeed, China's ambitious pursuit of neurotechnology that has civilian and military purposes, its focus on developing new operating concepts to leverage neuroweapons, and its possible use of neuroweapons all demonstrate China intends to use neurotechnology to further its ends.

2. China's Pursuit of Neurotechnology

The Chinese government is seeking to dominate the field of neuroscience, with China's Grand Strategy calling to be a world leader by 2030.[251] In 2016, China launched the

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[247] Boissoneault, "The True Story of Brainwashing and How It Shaped America."

[248] Boissoneault.

[249] "Data Leak Reveals How China 'Brainwashes' Uighurs in Prison Camps," *BBC News*, November 24, 2019, sec. China, https://www.bbc.com/news/world-asia-china-50511063.

[250] Yu, "Beijing's Woke Propaganda War in America."

[251] James Giordano, "Is Neuroscience the Future of Warfare?," *Defence IQ*, April 17, 2019, https://www.defenceiq.com/defence-technology/articles/neuroscience-and-future-warfare-1.

China Brain Project for the purpose of better understanding the human brain—mostly in response to the U.S. BRAIN Initiative launched in 2013—and is expected to invest billions of dollars in funding through 2030.[252] Interestingly, the Chinese Central Military Commission (CMC) launched a parallel effort to the China Brain Project that will explore the use of neuroscience for military applications, demonstrating the synergy China hopes to achieve through its civilian and military research efforts.[253]

China's investment in neuro S&T research has already led to some significant breakthroughs, such as the development of a new BCI chip that greatly enhances the performance and efficiency of prior BCI models, as well as makes an important progression in AI.[254] Indeed, China's Brain Project explicitly emphasizes the use of BCIs more so than U.S. efforts, and it's military and civilian fusion of BCI means China is more likely to adopt BCIs for military usage than the United States.[255]

Not only is China taking measures to develop its neurotechnology base through its civilian and military programs, but it has various factors working in its favor to possibly exceed the United States in these developments. One benefit for China is the CCP's Military-Civil Fusion (MCF) strategy, defined as predominance over the Chinese economy, military, and society writ large, enabling it to direct resources and collaboration across the academic, research, industry, and military sectors to develop the People's Liberation Army (PLA) into a "world class military" by 2049.[256] Furthermore, whereas the United States and Europe have reduced primate research due to ethical concerns, China not only continues to do so but has expanded its neuroscience research on non-human primates, which can potentially lead to

252 Elsa B. Kania, "Minds at War: China's Pursuit of Military Advantage through Cognitive Science and Biotechnology," *PRISM* 8, no. 3 (January 2020): 89.

253 Kania, 85.

254 Kania, 88.

255 Joy Putney, "Neurotechnology for National Defense: The U.S. and China," *The Cipher Brief* (blog), July 1, 2021, https://www.thecipherbrief.com/column_article/neurotechnology-for-national-defense-the-u-s-and-china.

256 "Military-Civil Fusion and the People's Republic of China," Department of State, 2017–2021, https://www.state.gov/wp-content/uploads/2020/05/What-is-MCF-One-Pager.pdf.

great neurological research gains than Western countries.[257] Moreover, technologies like BCIs involve the collection of a large amount of personal data, specifically an individual's brain activity.

Recent surveys have indicated that Chinese citizens are not only more supportive than U.S. citizens over data collection of individuals but are generally favorable to government usage of that data whereas U.S. citizens were generally unfavorable.[258] Put simply, neuro S&T is a sensitive field that raises various ethical concerns, and the Chinese government and Chinese people—generally—are more tolerant of this new technology than those in the United States. The lack of ethical concerns combined with China's aggressive research and the CCP's ability to better synchronize efforts demonstrates China's major advantages and makes it likely China will find ways to effectively militarize this emerging technology in future years.

3. Cognitive Domain Operations and New Concept Weapons

While China is establishing an important scientific base for the development of neurotechnology, it has also explicitly called for the development of neurological weapons and has established new operating concepts to be able to leverage such weapons. Known as "new concept weapons" (NCW), these weapons range from energy-based (such as directed-energy weapons), information based (advanced computer systems), and even biological/ chemical weapons (such as gene editing) to achieve military advantage over an advanced adversary like the United States.[259] While not all of these are necessarily neuroweapons, many of them, especially directed-energy weapons, can be used in such a capacity and at minimum most of the NCWs are specifically designed to influence behavior. Indeed, the PLA claims the goals of such weapons are to "disorient enemy minds, weaken their willpower, and

[257] Kania, "Minds at War: China's Pursuit of Military Advantage through Cognitive Science and Biotechnology," 90.

[258] Putney, "Neurotechnology for National Defense."

[259] Marcus Clay, "New Concept Weapons: China Explores New Mechanisms to Win War," *Jamestown Foundation*, China Brief, 21, no. 8 (April 23, 2021), https://jamestown.org/program/new-concept-weapons-china-explores-new-mechanisms-to-win-war/.

deprive their fighting spirit."[260] With the importance China places on the information domain and gaining asymmetries, it's reasonable to believe NCWs will likely make up a key part of China's arsenal in the coming decades.

The PLA is also developing new warfighting concepts, or doctrine, for psychological warfare called "cognitive domain operations" that would be able to leverage NCWs.[261] In essence, China believes the human mind is the next domain of warfare, moving away from the traditional domains of land, sea, and air, and, along with using newer domains of cyber and space, seeks to achieve "mind superiority" to influence adversary behavior.[262] An August 2018 article from China's National University of Defense Technology listed some weapons categories that are explicitly tied to the neurowarfare concepts of degradation and enhancement, labeled as "cognitive interference technology" (degradation), and "cognitive strengthening technology" (enhancement).[263] In other words, China not only understands the advantages neuroweapons can provide it, but is also taking steps to develop them and building strategies for how best to operationally employ them for maximum effect.

4. Has China Used Neuroweapons?

In addition to the previously mentioned Havana Syndrome attacks at the U.S. Consulate in Guangzhou, China, in 2017 and 2018, consider another case of potential neuroweapon usage by China. In November of 2020, Jin Canrong, the Deputy Dean of the School of International Relations at Renmin University in Beijing, claimed in August of 2020 the PLA used a non-lethal microwave weapon against Indian soldiers to retake a strategic hilltop from the Indian Army in disputed territory in Ladakah, near Tibet.[264] In August 2020, as tension rose in the disputed border region between China and India—including the deaths of 20 Indian soldiers at the hands of Chinese troops, clubbed no less—India captured two

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[260] Clay.

[261] Beauchamp-Mustafaga, "Cognitive Domain Operations."

[262] Beauchamp-Mustafaga.

[263] Beauchamp-Mustafaga.

[264] Aakriti Sharma, "Has India Finally Acknowledged That Chinese PLA Used Microwave Weapons Against Indian Soldiers In Ladakh?," *The EurAsian Times*, January 6, 2021, https://eurasiantimes.com/has-india-finally-acknowledged-that-chinese-pla-used-microwave-weapons-against-indian-soldiers-in-ladakh/.

strategic heights in the region, providing them with an advantageous view of a nearby Chinese garrison.[265] Notably, since 1996 both India and China agreed that troops in this region would not use firearms or explosives, so Canrong claimed the use of a microwave weapon—which after 15 minutes of use allegedly left the Indian soldiers vomiting and unable to stand—"solved the problem beautifully" and allowed the PLA to retake the hilltops.[266] India immediately denied this event happened, claiming "the news is FAKE." They also suggested that if the event did indeed happen it is likely something India would want to conceal.[267]

It is difficult to establish the veracity of this event because the only evidence provided from China is the claim from the professor, which was several months after the alleged incident took place. Indeed, the majority of observers believe this event likely did not happen, and it remains unresolved.[268] However, while India remains adamant this did not happen, a year-end review of India's Ministry of Defense claimed that China used "unorthodox weapons" along the Line of Actual Control (LAC) in the disputed territory, though what constitutes an unorthodox weapon is not specified in the report.[269]

Even if disputed, the event is significant because it demonstrates the *aspirations* of deploying a microwave weapon in a combat setting. This mindset from a U.S. competitor adversary should not go unnoticed. China is believed to be in possession of DEWs, as a Chinese company in 2014 showed off a prototype WB-1 Anti-Riot System, though evidence is lacking this system was ever produced for operational purposes.[270] While there have been numerous cases of Havana Syndrome, those cases were almost always targeting individuals,

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265 Sharma.

266 David Hambling, "India Disputes Claim That China Routed Their Troops With Microwave Blaster," *Forbes*, July 19, 2021, https://www.forbes.com/sites/davidhambling/2020/11/20/disputed-claim-that-china-routed-indian-troops-with-microwave-blaster/.

267 Hambling.

268 Manoj Joshi and Pushan Das eds, "The Future of War in South Asia: Innovation, Technology and Organisation," *Observer Research Foundation and Global Policy Journal*, 2021, 42–43.

269 Sharma, "Has India Finally Acknowledged That Chinese PLA Used Microwave Weapons Against Indian Soldiers In Ladakh?"

270 Hambling, "India Disputes Claim That China Routed Their Troops With Microwave Blaster."

not entire military formations.[271] On the one hand, if this event did occur then it would be the first of its kind and demonstrate that China has a weapon that could be wielded with great effect.[272] On the other hand, if this event did not occur then it represents a likely psychological operation on the part of China, using an academic and not an official PLA spokesperson.

B. RUSSIA

The following section refers to Russia.

1. Brain Research and Neurotechnology

Russia as a government and a society has shown an interest since the 19th century in the study of the human mind and how it can be influenced. In 1890, a Russian psychology society formed a commission to study mind reading and in 1907 Czar Nicholas II decreed the founding of the St. Petersburg Research Institute of Neuropsychiatrics.[273] After the Russian Revolution in 1917, the Soviet Union continued some of this research from the Czarist era. During the 1930s, the Brain Institute in Leningrad studied the effects of transferring visual images and remotely influencing human subjects in order to study the possibility of telepathy.[274] As the Soviets studied the brain and electromagnetic energy, they concluded by at least 1942 that electromagnetic energy can affect the central nervous system.[275] This and other unconventional research continued in earnest during the Cold War—with a high-end estimate of $1 billion spent on such research during that time—primarily at the behest of the KGB and the Ministry of Defense.[276]

Though lacking the resources it once had devoted to brain research under the Soviet Union, Russia is earnestly pursuing neurotechnology that it could potentially harness for

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[271] Dilanian, Lederman, and Kube, "Up to 200 Americans Have Reported Possible 'Havana Syndrome' Symptoms."

[272] Hambling, "India Disputes Claim That China Routed Their Troops With Microwave Blaster."

[273] Serge Kernbach, "Unconventional Research in USSR and Russia: Short Overview," *Cybertronica Research, Research Center of Advanced Robotics and Environmental Science*, December 5, 2013, 3, https://arxiv.org/pdf/1312.1148.pdf.

[274] Kernbach, 4.

[275] Kernbach, 4.

[276] Kernbach, 17.

military purposes. Russia has sought to establish itself as a neurotechnology hub by providing government funding to startup companies and opening up collaboration with academic research groups.[277]

In 2019, Russian neurotechnology developers visited the United Kingdom to establish ties with professionals that use neurotechnology to rehabilitate patients with brain and spinal injuries.[278] Moreover, the Brain and Consciousness Research Center in Moscow is establishing a new lab that will be led by a Nobel laureate in order to develop new technologies such as neuromorphic computing—computer processors that attempt to operate like the human brain, which has a range of functions but is ideal for studying the brain.[279] Russia has also achieved some notable gains in neurotechnology. For example, researchers working on a 2019 project between the Russian company Neurobotics and the Moscow Institute of Physics and Technology discovered a way "to visualize a person's brain activity as actual images mimicking what they observe in real time," which will enable stroke victims to use devices controlled by their brain.[280] Despite these gains, Russia does lag the United States, EU, and China significantly when it comes to neuroscience, accounting for only 0.8% of the total number of academic publications in the field.[281]

2. Reflexive Control and Active Measures

In addition to historical brain research and development of neurotechnology, Russia has been ideologically committed to influencing individuals' and even states' behavior in order to accomplish its objectives. Russia employed the concepts of reflexive control and

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277 Carlos De Rojas, "Top Neurotech Startups Unlocking the Brain in Russia," *Labiotech.Eu* (blog), February 10, 2021, https://www.labiotech.eu/best-biotech/neurotech-startups-russia/.

278 Andrew Mernin, "A Russian Revolution in Neuro Tech," *NR Times* (blog), July 20, 2019, https://www.nrtimes.co.uk/a-russian-revolution-in-neuro-tech/.

279 Marek Grzegorczyk, "Nobel-Laureate to Head New Russian Lab Developing Neuromorphic Technology," *Emerging Europe*, February 11, 2021, https://emerging-europe.com/news/nobel-laureate-to-head-new-russian-lab-developing-neuromorphic-technology/.

280 Vladimir Konyshev, "Neural Network Reconstructs Human 'Thoughts' from Brain Waves in Real Time," *Moscow Institute of Physics and Technology* (blog), October 30, 2019, https://mipt.ru/english/news/neural_network_reconstructs_human_thoughts_from_brain_waves_in_real_time.

281 Irina G. Dezhina and Tamam N. Nafikova, "Global Landscape of Neuroscience and Place of Russia," *Mirovaia Ekonomika i Mezhdunarodnye Otnosheniia* 64, no. 9 (September 29, 2020): 37–47, https://doi.org/10.20542/0131-2227-2020-64-9-37-47.

active measures during the Cold War with various degrees of success. Reflexive control is a technique whereby certain information is presented to an opponent to get that opponent to make a predetermined decision desired by the initiator, otherwise known as manipulation, and is somewhat analogous to military information support operations (MISO) in U.S. military parlance.[282] However, reflexive control plays a more central role in Russian actions than MISO does with the United States. Seen as a subset of information warfare through the use of accurate information as well as misinformation or disinformation, the Soviets and now the Russians believe it can play an important role in political and military contests.[283] One example of reflexive control during the Cold War concerned influencing U.S. perceptions of the strength of Soviet nuclear missile capability. The Soviets developed fake missiles with larger than normal warheads, conducted a military parade that they knew would be attended and reported on by foreign military attaches, and developed additional disinformation measures in order to confuse Western intelligence services.[284] The goal of this highly elaborate ruse was to essentially waste foreign scientists time and money in trying to obtain this nonexistent advanced technology.[285]

While reflexive control attempts to influence an opponent to make a predetermined decision, active measures are a more comprehensive approach to influence the strategic environment, as well as an opponent's decision making. Mark Gelotti, a British scholar on Russia, writes that the term active measures dates back to the 1950s and refers to a "gamut of covert and deniable political influence and subversion operations, including but not limited to the establishment of front organizations, the backing of friendly political movements, the orchestration of domestic unrest, and the spread of disinformation.[286]" Indeed, additional actions include media manipulation, covert broadcasting, incitement, assassination, and even

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[282] Timothy Thomas, "Russia's Reflexive Control Theory and the Military," *Journal of Slavic Military Studies*, 2004, 237, https://doi.org/10.1080/13518040490450529.

[283] Thomas, 240.

[284] Thomas, 253.

[285] Thomas, 253.

[286] Mark Galeotti, "Active Measures: Russia's Covert Geopolitical Operations," *Security Insights*, June 2019, http://www.marshallcenter.org/en/publications/security-insights/active-measures-russias-covert-geopolitical-operations-0.

terrorism.[287] Notably, during the peak of active measures during the Cold War, there were an estimated 15,000 people dedicated to its various campaigns, a number higher than the number of post-9/11 U.S. diplomats worldwide.[288]

Though there was a reduction in active measures after the end of the Cold War in an attempt to improve ties with the West, these measures have increased significantly under Russian President Vladimir Putin, and now make up a major component of Russia's overall strategy.[289] Russia under Putin embraces a strategic culture which believes that various adversaries in the West —primarily the United States—are out to undermine Russia and its institutions.[290] This is partly because of Putin's background as a KGB agent, but is also due to the various color revolutions that took place in former Soviet-dominated countries, as well as the Arab Spring, which reaffirmed Putin's suspicion that the West was forever hostile to Russia.[291] Due to this perceived subversive threat, the Putin regime has reembraced active measures and reflexive control in order to proactively counter and undermine the West.[292]

3. Russia's Views on Neurowarfare

Whereas reflexive control and active measures are more akin to psychological operations, information warfare, or even political warfare, Russia has also embraced the tenets of neurowarfare and neuroweapons to potentially influence its adversaries. Chapter III mentioned Russia's interest in microwave weapons in order to target the brain, a capability it is likely utilizing with the Havana Syndrome cases. However, Russia has shown interest in other types of weapons that can create neurological effects. In 1991, Russia demonstrated a technique where researchers analyzed the brain electronically for the purpose of influence by

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[287] Steve Abrams, "Beyond Propaganda: Soviet Active Measure's in Putin's Russia," *Connections: The Quarterly Journal* 15, no. 1 (2016): 11, http://dx.doi.org/10.11610/Connections.15.1.01.

[288] Abrams, 8.

[289] Galeotti, "Active Measures."

[290] Galeotti.

[291] Galeotti.

[292] Galeotti.

inputting subliminal command messages through white noise or music.[293] The Russians have also allegedly developed a computer virus they call Virus 666, which they claim can produce a variety of colors on a display that will put a person into a trance.[294] Moreover, a concept known as "psychotronic weapons" has garnered attention in Russia. A psychotronic weapon aims to take away some information from a person's brain, send it to a computer, rework the information, and then reinsert it into the brain in order to induce hallucinations, sickness, or even death.[295] While it is not clear whether these weapons exist, these capabilities were being researched and discussed in the 1990s, and demonstrate Russia's belief in their utility.

Russia has not only sought to develop various neuroweapons, but also openly acknowledges the importance of targeting the brain to gain military advantage. In 2018, a Russian military journal published a list of technologies that could be used for reflexive control and explicitly mentions technologies that can target the "cognitive."[296] A year prior, a professor of Russia's Combined Arms Academy articulated that he anticipated future wars will see a combination of information and cyberwar that will ultimately provide inputs for "psywars" and "neurowars," though he didn't elaborate on either of those terms.[297] However, the insinuation is that the mind will be a new domain of fighting—possibly the most important domain—and will rely heavily on the operating environment created by cyber and information. Ultimately this new form of warfare will emphasize manipulating the adversary, which will require the development of new types of theories to best fight.[298]

C. COMPARISON OF CHINA AND RUSSIA ON NEUROWARFARE

China and Russia have some notable similarities but also important differences when it comes to their respective neurowarfare views and capabilities. Both countries have a long

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293 Timothy Thomas, "The Mind Has No Firewall," *The U.S. Army War College Quarterly: Parameters* 28, no. 1 (Spring 1998): 2–17.

294 Thomas.

295 Thomas.

296 Timothy Thomas, "Russian Military Thought: Concepts and Elements," *MITRE Product*, August 2019, 4–8.

297 Thomas, "Russian Forecasts of Future War," 90.

298 Thomas, 90–91.

history of attempting to influence behavior through targeting the brain, whether it's China's use of brain washing or Russia's unconventional research efforts. Russia and China share a commonality of authoritarian regimes who rose to power through communist revolutions—though at different times and under much different circumstances—that greatly influence both countries views on information and coercive behavior. China and Russia have both embraced a more holistic concept of warfare than the United States has, where gray zone activities, subversion, and other measures are all done to advance its interests that fall short of traditional forms of conflict. Additionally, both countries have clearly embraced the idea of neurowarfare in their academic literature, which is an indicator for their elite's mindset. They see the benefits of neurowarfare conceptually and the development of neuroweapons to gain asymmetric advantage militarily and politically. As such, neurowarfare and neuroweapons will likely continue to gain prominence for both countries, particularly as neuro S&T advances.

While both countries are developing neuroweapons, Russia at this time appears to be farther along. Some of this is likely due to the decades of research dedicated to their development conducted during a time when the Soviet Union had greater resources than China. Russia is likely the country behind Havana Syndrome and has more examples of weapons it is attempting to develop in this field than China, at least that is publicly available. However, Russia's neurotechnology sector lags greatly behind China, and Russia's gross domestic product (GDP) is about one-sixth of China's economy when measured by purchasing power parity (PPP).[299] This combined with the fact that China has made the development of neurotechnology a priority—and has the resources and the governing structure to ensure it is one—means China is more likely in the long-term to develop the most capable neuroweapons.

In some ways, where China and Russia stand on neuroweapons and neurotechnology reflects the current state of competition between them and the United States. Russia, a former superpower with a declining population and underdeveloped economy, retains enough

[299] The World Factbook, "Real GDP (Purchasing Power Parity)," CIA.gov, November 2, 2021, https://www.cia.gov/the-world-factbook/field/real-gdp-purchasing-power-parity/country-comparison.

capability to pose a threat to U.S. interests, or at least play the role of spoiler. Furthermore, it has the intent to do just that as it challenges the United States in Europe and other places globally. And so it is with neurowarfare. Russia appears to be actively using its current neurowarfare capability through the Havana Syndrome cases to create often-times strategic dilemmas for the United States. When it comes to neurowarfare and more traditional capabilities, Russia is the more immediate short-term threat to the United States.

On the other hand, China—a rising power that has the second largest economy in the world and an increasingly capable military—is beginning to challenge the United States in a more strategic way. Though there are variety of avenues for potential conflict between China and the United States—the South China Sea and Taiwan, to name just two—the threat from China is less imminent but more long-term than Russia. China's capability for neurotechnology and neurowarfare is also a more long-term threat. Though currently lacking the capability of Russia, China's emphasis on neuro S&T, desire to create neuroweapons, and nascent development of neurowarfare theories means it is highly likely to outpace Russia in these avenues. As a result, China in the 2030s and beyond has the potential to have a robust neurowarfare capability that has the possibility of posing significant challenges to the United States as it competes for global influence.

VI. SUMMARY, RECOMMENDATIONS, & FUTURE RESEARCH

> Ultimately, there is no higher valuation in war than subversion of the enemy's mind. If this can be achieved through targeting the enemy's brain directly, it would be the most powerful weapon that has ever been devised by humanity.
>
> –Dr. Armin Krishnan, 2016[300]

This thesis makes the case that neurowarfare represents a new domain of war that is not only already here but will grow in importance as neuro S&T develops and matures. Indeed, this hypothesis is based on the persuasive arguments made by a growing number of academics, scientists, and thinkers over the past few decades but has recently been brought into sharper focus with the real-world Havana Syndrome cases, as well as the current strategic environment and competitors' actions in this space. Neurowarfare has the potential to radically change the nature of warfare and the state that can harness this potential first will gain a key strategic advantage over potential adversaries.

A. SUMMARY

Chapter II cataloged the various advances in neuro S&T that have provided a fuller, collective understanding of how the brain functions. Though U.S. government efforts at understanding the brain date back to the early years of the Cold War, it has been the technological revolution of computing the past three decades that has critically propelled this emerging field by leveraging communication synergies. When it comes to possible weaponization of neurotechnology, the authors used the United Kingdom's 2012 Royal Society report to distinguish between performance enhancement and performance degradation to best categorize various technologies. While enhancement has clear utility for both military and civilians, degradation technologies will likely be used most often in military, law enforcement, or national security settings for the foreseeable future.

300 Krishnan, "Attack on the Brain: Neurowars and Neurowarfare," 20.

Chapter III explored the myriad of Havana Syndrome cases that have taken place against the United States across the globe since 2016. As of this writing, there have been an estimated over 200 cases against U.S. officials in at least 16 countries and the targets are often members of the U.S. Intelligence Community (IC). Though much uncertainty continues to surround these cases, the available evidence suggests a directed-energy, microwave weapon is responsible for these attacks, and that Russia is the state behind them. Havana Syndrome poses unique challenges to the United States since it is plausibly deniable and yet has effects ranging from the tactical all the way to the strategic, with the cool down of relations between the United States and Cuba being the most significant. These challenges center around deterring and responding to such attacks. If left unaddressed, these cases will continue to plague U.S. efforts to operate effectively overseas and in particular damage our intelligence collection capability.

Chapter IV contended that Great Power Competition is nothing new in the history of the international system, but the United States is now placing more emphasis on peer and near-peer adversaries instead of on non-state actors during the Global War of Terrorism. GPC is characterized by gaining influence through the full range of the instruments of power at a state's disposal. A large component of this is ideological, as a particular country advances a certain narrative about itself and its adversaries to sway global opinion. While also not new, much of the competition today takes place within the gray zone, something China and Russia do with great effect. Neurowarfare represents the newest manifestation of these gray zone activities that will only become more pronounced with the advancement of neuro S&T.

Chapter V contrasted the views and efforts of China and Russia toward neuroweapons and neurowarfare. Both countries operate from worldviews that emphasize control and wanting to influence beliefs, making the concept of influencing the mind in line with their strategic thinking. Both countries are investing in neuro S&T, with China notably seeking to be a world leader in this field by 2030. Importantly, both countries have explicitly articulated the military benefit of developing weapons that can influence behavior and are developing concepts and weapons to make that benefit a reality. Though

Russia appears to be further along in terms of capability, it is likely a matter of time before China becomes the bigger threat in the neuro domain.

B. RECOMMENDATIONS

This paper seeks to awaken the national security community to neurowar in a similar manner that Dr. Arquilla and Dr. Ronfeldt did in their "Cyberwar is Coming!" article published in 1993. That article discussed the broad changes from the information revolution three decades ago: "Sea changes are occurring in how information is collected, stored, processed, communicated and presented, and in how organizations are designed to take advantage of increased information."[301] Now that information systems have become ubiquitous within global society, even to the point of being overwhelmed with information, the next phase will involve how information is received, analyzed, and applied by the human brain to turn information into action. Neuro S&T R&D is focused on solving that exact challenge, by better understanding how the brain works and then seamlessly integrating new technologies to capture and unlock the brain's potential. With that advancement comes great danger in mind influence, manipulation, and possibly control. However, in recognition that so much of the current research and analysis of neurowar occurs in the classified space, and hence unbeknownst to us, specific recommendations are somewhat limited. Nevertheless, we pose several broad recommendations.

1. Awareness

The national security community, and especially the military, needs to stay keenly aware of the impending dangers of neurowar and its impacts on its personnel. As demonstrated, the national security community seems to be harvesting the potential from the performance enhancement revolution currently underway, as many organizations are investing in ways to leverage neuro S&T R&D for increased human performance. This paper is meant to call attention to the harmful events that are slowly merging into the public arena, and to provide context to the seemingly disjointed manner that neurowar is currently being conducted. All government officials, even those on American soil, are potentially

301 Arquilla and Ronfeldt, "Cyberwar Is Coming!," 143.

targets for RF waves that disrupt brain processes and severely impede normal operations. In a larger sense, all military professionals should always study societal trends and look for ways to integrate and improve into military processes, especially in matters of protection.

2. Pursue Degradation?

The United States should decide whether to pursue degradation technologies or not, and if so, to what degree. The authors take no stance on this but believe that the U.S. government needs to begin thinking about whether neuroweapons are something that should be included in the U.S. weapons arsenal and what role they might play in national defense. Admittedly, this is not an easy task due to the newness of the technologies and the serious ethical issues that come from developing and wielding weapons with such power. History has shown that if a weapon is created, it increases the probability of employment, as nuclear weapons were eventually used, albeit only twice. When making these decisions, it would be beneficial to consult with relevant experts—scientists, business leaders, military officers, policymakers, and ethicists, to name a few—as there are numerous second and third order effects that spillover into many areas and industries. One thing is certain, though, and that is Russia and China *are* pursuing these weapons and do not have the same moral qualms that the United States does in developing and obtaining them. This is not to say that the United States must develop them to counter these two states, but rather to be clear-eyed and sober-minded as to what our competitors are doing in this space.

3. Track Neuro S&T and Neuroweapon Development

The United States should also continue to place energy and resources behind monitoring the development of neurotechnology and neuroweapons. We have laid out in a completely unclassified forum a detailed analysis of the Havana Syndrome cases, the developments of neuroweapons and concepts of operations for China and Russia, and the logic behind why neuroweapons are likely going to increase given a strategic environment that emphasizes influence, but we're working with incomplete data (lack of access to classified material) and lack of technical expertise behind some of the various technologies in development. The establishment of various task forces within the interagency, and particularly the IC, to get to the bottom of the Havana Syndrome cases are certainly steps

in the right direction and demonstrate the United States is starting to take this threat seriously. However, more awareness should be raised within government, academia, research centers, and the private sector as to the dual-use nature of many of the developments within neuro S&T. The IC, in particular, should make the larger issues of neuroweapons—not just ones surrounding the Havana Syndrome—a priority to stay ahead of the curve and closely monitor important trends.

4. Respond to Neurowar Attacks

The United States also needs to determine how best to respond to neuroweapon attacks, which as of now and based on publicly available information is limited to the Havana Syndrome cases. Attribution is arguably the largest issue, but the asymmetric and non-lethal nature of the attacks also complicate possible responses. In many ways neuroweapon attacks are similar to cyber-attacks in that they are able to cause serious damage, whether they be economic, political, or chaos and confusion, but the lack of fatalities constrains responses. In the short term, the United States needs to signal something that it is pushing back against these attacks, particularly as the recent attacks in Vietnam, India, and Colombia all took place around high-ranking government officials visiting those countries. Long term, as these attacks and possibly other neuro attacks are likely to increase, the United States needs to decide how best to respond, to include possible military action, if the attack reaches that level.

C. FUTURE RESEARCH

There are numerous areas of further inquiry that this thesis brings to light. The ethical considerations for conducting brain research are front and center, and this paper has conveniently sidestepped them. Are the benefits worth the potential harm? Another area is the legality of brain research. Neurowar has many similarities to the rise of biological warfare during and immediately after World War II, as scientists worked to unlock the potential dangers and utility. However, development basically stopped overnight after international agreements prevented the weaponization of biological agents.[302] Is neurowar

[302] *The Living Weapon,* directed by John Rubin (2007; Boston, MA: PBS, 2007).

doomed to a similar fate? Or are new gray zone activities in this area ripe for competition and conflict? What are the current international efforts to restrict neuro S&T activities, and where does public opinion stand, especially with the potential upsides to heal cognitive degeneracies?

This thesis has sought to convey neurowar as the continuation of GPC by highlighting the centrality of influence. As the past several years has shown, information has increasingly been manipulated to influence domestic and foreign populations. When populations become hardened to these influence operations, is neurowar the next ring of escalation, and therefore the next logical step?

Dr. Arquilla and Dr. Ronfeldt asked many pertinent questions about cyberwar in their "Cyberwar is Coming!" article that are applicable here: "What would a [neurowar] look like? Are there different types? What may be the distinctive attributes of [neurowar] as a doctrine? Where does [neurowar] fit in the history of warfare—and why would it represent a radical shift? What are the requirements and options for preparing for and conducting a [neurowar]? Will it enable power to be projected in new ways? What are the roles of organizational and technological factors—and what other factors should be considered? How could the concept enable one to think better, or at least differently in a useful way, about factors…that are important but not ordinarily considered together? What measures of effectiveness should be used? These kinds of questions call for examination."[303]

Our ideas here are just a beginning. Neurowar has only just begun to rear its ugly head in one form. There are many possibilities for how this progresses. Many issues are left to be considered and analyzed more in-depth over time. Hopefully this thesis has laid a foundation and sparked an interest to continue the discussion.

[303] Arquilla and Ronfeldt, "Cyberwar Is Coming!," 154.

APPENDIX. NEURO S&T IN U.S. DOD ORGANIZATIONS

This appendix is intended to further document and support the claim that the United States is investing and progressing in neuro S&T for national security purposes within the U.S. DOD. It discusses research organizations within the DOD that are pushing the boundaries of neuro S&T research, including DARPA, IARPA, the Military Services, and USSOCOM. It will be demonstrated that the DOD is heavily invested in neuro S&T and has many organizations that are actively working on performance enhancement programs. While there is also some limited development of DEWs, their stated purposes are not directly associated with neuro effects.

A. DARPA

As mentioned in Chapter II, neuro S&T can be categorized as either performance enhancement or performance degradation. Within performance enhancement, there are three different categories—neuropharmacology, brain stimulation, and BCI. Based on available information, DARPA is not involved in neuropharmacology, so all of their programs falls into either brain stimulation or BCI, although many programs blur the lines and use multiple techniques. The following are a representative sample of DARPA's work:

- *CT2WS*, or Cognitive Technology Threat Warning System, is a BCI designed to be a soldier-portable visual threat warning device, integrating cameras with AI and operator brain signals to more accurately identify threats while reducing the cognitive workload on soldiers.[304]

- *ElectRx*, or Electrical Prescriptions program, is seeking to use brain stimulation mechanisms and BCI "to deliver non-pharmacological treatments for pain, general inflammation, post-traumatic stress, severe

304 Sterling, "Augmented Reality."

anxiety, and trauma that employ precise, closed-loop, non-invasive modulation of the patient's peripheral nervous system."[305]

- *HAPTIX*, or the Hand Prioprioception and Touch Interfaces program, "is pursuing key technologies to enable precision control of and sensory feedback from sensor-equipped upper-limb prosthetic devices."[306]

- *NSIA*, or Neural Signal Interfaces and Applications, program "is developing non-invasive neurotechnologies able to interface with the nervous system with high resolution and precision without surgery…[to] facilitate standard human-machine interfaces for improved workload balance between man and machine."[307]

- *NESD*, or the Neural Engineering System Design program, seeks to develop "advanced neural interfaces that provide high signal resolution, speed, and volume data transfer between the brain and electronics, serving as a translator for the electrochemical language used by neurons in the brain and the ones and zeros that constitute the language of information technology."[308]

- *Neuro-FAST*, or Neuro-Function, Activity, Structure, and Technology, program "seeks to open new pathways for understanding and treating brain injury, enable unprecedented visualization and decoding of brain

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[305] Eric Van Gieson, "Electrical Prescriptions (ElectRx)" (DARPA), accessed August 11, 2021, https://www.darpa.mil/program/electrical-prescriptions.

[306] Al Emondi, "Hand Proprioception and Touch Interfaces (HAPTIX)" (DARPA), accessed August 11, 2021, https://www.darpa.mil/program/hand-proprioception-and-touch-interfaces.

[307] Department of Defense, *Justification Book*, 1:44.

[308] Al Emondi, "Neural Engineering System Design (NESD)" (DARPA), accessed August 11, 2021, https://www.darpa.mil/program/neural-engineering-system-design.

activity, and build sophisticated tools for communicating with the brain."[309]

- N3, or Next-Generation Nonsurgical Neurotechnology, program "aims to develop high-performance, bi-directional brain-machine interfaces for able-bodied service members…for diverse national security applications such as control of unmanned aerial vehicles and active cyber defense systems or teaming with computer systems to successfully multitask during complex military missions."[310]

- *RAM*, or Restoring Active Memory, program "aims to mitigate the effects of TBI in military service members by developing a wireless, fully implantable neural interface to facilitate memory formation and recall in the injured brain."[311]

- *SUBNETS*, or Systems-Based Neurotechnology for Emerging Therapies, program is using brain implants and stimulation technologies to treat neuropsychiatric illnesses in military members.[312]

- *TNT*, or Targeted Neuroplasticity Training, program "supports improved, accelerated training of military personnel in multifaceted and complex tasks…[by] us[ing] non-invasive neurotechnology in combination with training to boost the neurochemical signaling in the brain that mediates neural plasticity and facilitates long-term retention of new cognitive skills. If successful, TNT technology would apply to a wide range of defense-

309 Tristan McClure-Begley, "Neuro Function, Activity, Structure, and Technology (Neuro-FAST)" (DARPA), accessed August 11, 2021, https://www.darpa.mil/program/neuro-function-activity-structure-and-technology.

310 Al Emondi, "Next-Generation Nonsurgical Neurotechnology" (DARPA), accessed August 11, 2021, https://www.darpa.mil/program/next-generation-nonsurgical-neurotechnology.

311 Tristan McClure-Begley, "Restoring Active Memory (RAM)" (DARPA), accessed August 11, 2021, https://www.darpa.mil/program/restoring-active-memory.

312 Al Emondi, "Systems-Based Neurotechnology for Emerging Therapies (SUBNETS)" (DARPA), accessed August 10, 2021, https://www.darpa.mil/program/systems-based-neurotechnology-for-emerging-therapies; Weinberger, *The Imagineers of War*, 371.

relevant needs, including foreign language training, marksmanship, cryptography, target discrimination, and intelligence analysis, improving outcomes while reducing the cost and duration of the Defense Department's extensive training regimen."[313]

B. IARPA

IARPA, or the Intelligence Advanced Research Projects Activity, is a similar organization established in 2006 within the Office of the Director of National Intelligence (ODNI) responsible for investing "in high-risk, high-payoff research programs to tackle some of the most difficult challenges" for the IC.[314] IARPA does not have an operational mission, but rather funds and facilitates academic and industry research across a range of technical areas relevant to the IC, and neuroscience is among its endeavors.[315]

The organization has several neuro S&T programs currently underway, realizing the potential return on investment for the IC.

- *ICArUS*, or Integrated Cognitive-Neuroscience Architectures for Understanding Sensemaking, program is attempting "to understand and model how humans engage in the sensemaking process, both during optimal and suboptimal performance."[316]

- *KRNS*, or Knowledge Representation in Neural Systems, program is seeking "to develop and rigorously evaluate theories that explain how the human brain represents conceptual knowledge."[317]

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313 Tristan McClure-Begley, "Targeted Neuroplasticity Training (TNT)" (DARPA), accessed August 11, 2021, https://www.darpa.mil/program/targeted-neuroplasticity-training.

314 "About IARPA," IARPA, accessed August 11, 2021, https://www.iarpa.gov/who-we-are/about-us.

315 IARPA.

316 "Integrated Cognitive-Neuroscience Architectures for Understanding Sensemaking (ICArUS)" (IARPA), accessed August 11, 2021, https://www.iarpa.gov/research-programs/icarus.

317 "Knowledge Representation in Neural Systems (KRNS)" (IARPA), accessed August 11, 2021, https://www.iarpa.gov/research-programs/krns.

- *MICrONS*, or Machine Intelligence from Cortical Networks, program "seeks to revolutionize machine learning by reverse-engineering the algorithms of the brain."[318]

- *SHARP*, or Strengthening Human Adaptive Reasoning and Problem-solving, program is "developing non-invasive neural interventions for optimizing reasoning and problem-solving."[319]

All of these programs are designed to aid the IC in the tasks of analysis and assessment making, which have become increasingly difficult due to the sheer quantity of information available to intelligence analysts.

C. MILITARY RESEARCH INTO NEURO S&T

The U.S. military is also rapidly embracing the potential of neuro S&T and is investing across all the Services. As recently as 2008, the National Research Council of the NAS "reported that the brain sciences showed potential for military and warfare applications, but were not yet wholly viable for operational use."[320] By 2014, they had reversed course in a report titled "Emerging and Readily Available Technologies and National Security: A Framework for Addressing Ethical, Legal, and Societal Issues," stating that "developments in the field had progressed to the extent that rendered the brain sciences viable, of definitive value, and a realistic concern for the military."[321] Ethical issues aside, the capabilities to create and exploit new technologies to harness the power of the brain are happening now across the Services.

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318 "Machine Intelligence from Cortical Networks (MICrONS)" (IARPA), accessed August 11, 2021, https://www.iarpa.gov/research-programs/microns.

319 "Strengthening Human Adaptive Reasoning and Problem-Solving (SHARP)" (IARPA), accessed August 11, 2021, https://www.iarpa.gov/research-programs/sharp.

320 Giordano, "Weaponizing the Brain."

321 Giordano.

1. U.S. Air Force (USAF)

The Air Force Office of Scientific Research (AFOSR), which falls under the Air Force Research Laboratory (AFRL), is leading basic research efforts to support USAF requirements by investing in "areas that offer significant and comprehensive benefits to our national warfighting and peacekeeping capabilities."[322] The Chemistry and Biological Sciences Team, which is one of four scientific divisions organized under AFOSR, is responsible for neuro S&T research and is actively providing grants in this realm.[323] At the time of this writing, there are two funding opportunities through the AFRL Center of Excellence (COE) model. The Neuroscience of Decision Making COE "seeks to advance scientific understanding of the neuroscience foundation of Decision Making in the context of goal-directed activity and especially under stressful conditions." The Brain-Derived Neuromorphic Computing with Intelligent Materials COE "aims to support high-risk, high-reward basic research that will address the hardest challenges currently facing neuromorphic computing."[324]

The USAF also has the 711th Human Performance Wing (HPW), organized under AFRL, with the mission of using cutting-edge research to advance human performance.[325] The Airman Systems Directorate, which resides under this Wing, is charged with "studying developing technologies specific to the human element of warfighting capability."[326] There is a Cognitive Neuroscience program under this Directorate that is actively looking for ways to leverage research being done in academia and the private sector towards USAF

322 "Air Force Office of Scientific Research," AFRL, accessed August 12, 2021, https://www.afrl.af.mil/AFOSR/.

323 "AFOSR - Chemistry and Biological Sciences," AFRL, August 24, 2020, http://www.afrl.af.mil/About-Us/Fact-Sheets/Fact-Sheet-Display/Article/2282132/afosr-chemistry-and-biological-sciences/.

324 "AFRL/AFRL Center of Excellence FOAs," APEX, accessed August 12, 2021, http://apex-innovates.org/events/afrlafrl-center-excellence-foas.

325 "711th Human Performance Wing," AFRL, accessed August 12, 2021, https://www.afrl.af.mil/711HPW/.

326 "Human Performance Wing Human Systems Integration Directorate," AFRL, accessed November 16, 2021, https://www.afrl.af.mil/711HPW/RH/.

goals and priorities.[327] The 711 HPW recently signed a Cooperative Research and Development Agreement (CRADA) with Rio Grande Neurosciences in Albuquerque, New Mexico with the goal to leverage new technologies from the private sector back into the Air Force.[328] This specific study will explore tDCS success rates by testing human subjects: "The 711 HPW has been studying tDCS for nine years in order to learn the method's effect on learning, memory, visual search, creativity, and decision making. The research has shown that the method can facilitate learning and improve attention span and reaction time. It is also pain-free and non-invasive."[329]

The 711 HPW's recent research into brain stimulation techniques are providing promising results to combat fatigue and improve cognitive function as well.[330] The technique is called cervical transcutaneous vagal nerve stimulation (ctVNS) and the study has shown "to mitigate the negative effects of fatigue on cognition and mood" with a wide range of potential military applications.[331] This could potentially decrease the habitual dependence on caffeine that is prevalent throughout the military, and much of the world.

2. U.S. Army (USA)

Similar to the USAF, the U.S. Army Research Laboratory (ARL), nestled under Army Futures Command, is the Army's fundamental research laboratory charged with scientific discovery, innovation, and bringing new capabilities to the USA.[332] There are

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[327] Leslie Heck, "Nano-Bio Materials Consortium Introduces New AFRL-Industry Co-Development Program with Rec," AFRL, May 27, 2021, http://www.afrl.af.mil/News/Article/2637256/nano-bio-materials-consortium-introduces-new-afrl-industry-co-development-progr/.

[328] "AFRL's 711th HPW Signs CRADA to Study Transcranial Direct Current Stimulation," FLC, accessed August 26, 2021, https://federallabs.org/successes/success-stories/afrl%E2%80%99s-711th-hpw-signs-crada-to-study-transcranial-direct-current.

[329] FLC.

[330] Thomas Gnau, "Neuromodulation Leads to Eye-Opening Findings at AFRL," *Dayton Daily News*, June 30, 2021, https://www.daytondailynews.com/local/neuromodulation-leads-to-eye-openings-findings-at-afrl/IGAQYCTI6NFI7EIVFIEVLBD7WE/.

[331] Lindsey K. McIntire et al., "Cervical Transcutaneous Vagal Nerve Stimulation (CtVNS) Improves Human Cognitive Performance Under Sleep Deprivation Stress," *Communications Biology* 4, no. 1 (June 10, 2021): 1–9, https://doi.org/10.1038/s42003-021-02145-7.

[332] "DEVCOM Army Research Laboratory," Army Research Lab, accessed August 12, 2021, https://www.arl.army.mil/.

many active projects to harness neuro S&T, but one of the most promising is meta-analysis of brain-imaging data from EEG to better understand the cognitive state of Soldiers and the relationship to performance during missions.[333] The first step to developing the next generation of neurotechnologies to enhance the performance of Soldiers begins with understanding.

Another area of interest for the USA is using the brain as the primary means of communication. In 2008, the USA began pursuing 'synthetic telepathy,' a technology designed to allow military members to communicate using only their brains.[334] By 2020, progress had been made towards that goal when the USA announced they had "successfully separated brain signals that influence action or behavior from signals that do not," and committed $6.25 million in funding to the project through 2025.[335] If developed, this could greatly decrease both the communications gear soldiers carry with them, and revolutionize the entire communications architecture that is vulnerable to EMP-type attacks.

The DOD has entered the fray in creating weapons that have the technological potential to be used as neuroweapons, although that is not their stated or primary intent. The USA and USMC have been active in creating non-lethal weapons in order to give military options to disrupt hostile activities without causing kinetic effects or collateral damage. The USA has created a prototype system called Solid State Active Denial Technology, or SS-ADT, which "is a DEW that uses RF millimeter waves at 95 GHz traveling at the speed of light to create a brief intolerable heating sensation on the person's skin at tactically useful ranges."[336] See Figures 1 and 2. The beam of RF energy only penetrates "about 1/64th of an inch into the skin," causing an immediate response to

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[333] Army Research Laboratory, "Army Develops Big Data Approach to Neuroscience," U.S. Army, February 5, 2020, https://www.army.mil/article/232275/army_develops_big_data_approach_to_neuroscience.

[334] Eric Bland, "Army Developing 'Synthetic Telepathy,'" *NBC News*, October 13, 2008, https://www.nbcnews.com/id/wbna27162401.

[335] Andrew Eversden, "Could Soldiers Silently Communicate Using Brain Signals in the Future?," *C4ISRNet*, November 25, 2020, https://www.c4isrnet.com/battlefield-tech/it-networks/2020/11/25/could-soldiers-silently-communicate-using-brain-signals-in-the-future/.

[336] Lauren Poindexter, "ARDEC Engineers Develop Solid State Active Denial Technology for Non-Lethal Crowd Control," U.S. Army, October 16, 2016, https://www.army.mil/article/176579/ardec_engineers_develop_solid_state_active_denial_technology_for_non_lethal_crowd_control.

flee.[337] The sensation immediately subsides once outside the RF beam. The most common usage is crowd control, and this technology could easily be transferred to law enforcement organizations throughout the country. In demonstration videos, the system is mounted onto a vehicle, but with more development could be miniaturized, carried on an individual person, and used for more nefarious purposes.[338]

Figure 1. Solid State Active Denial System.[339]

[337] Poindexter.

[338] Brittany Fogel, "Solid State - Active Denial Technology," DVIDS, accessed July 15, 2021, https://www.dvidshub.net/video/304622/solid-state-active-denial-technology; David B. Law, "Directed Energy (DE) Intermediate Force Capabilities (IFCs): Relevant Across the Range of Military Operations," 7, https://jnlwp.defense.gov/Portals/50/Documents/Resources/Presentations/DSIAC-Webinar-DE-Intermediate-Force-Capabilities.pdf?ver=nIDCf75TAytk16Je3N5hkg%3d%3d.

[339] Source: The Washington Times, "Game Changer: America's Most Advanced Weapons," *The Washington Times*, accessed November 4, 2021, https://m.washingtontimes.com/multimedia/collection/game-changer-americas-most-advanced-weapons/?page=10.

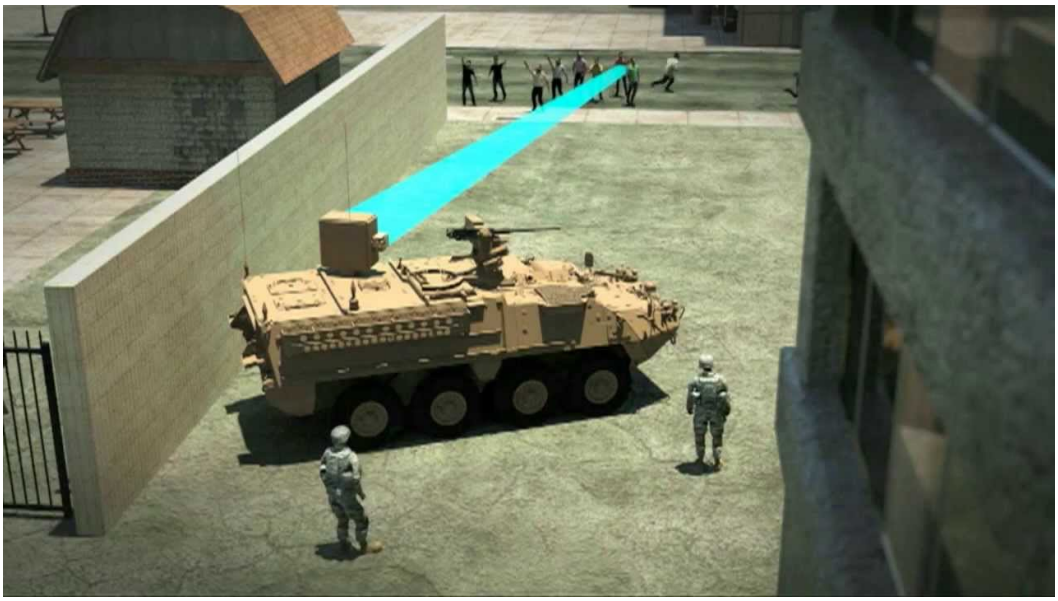

Figure 2. Potential Use of Solid State Active Denial System.[340]

Finally, the Walter Reed Army Institute of Research created the Center for Military Psychiatry and Neuroscience (CMPN) to "identify and eliminate brain health threats to soldiers," and is leading efforts to safeguard brain performance across the myriad of threats associated with military service.[341] Efforts in the medical space to improve neurological and psychiatric care are extensive and clearly fall under performance enhancement.

3. U.S. Navy (USN)

The Office of Naval Research (ONR) oversees the science and technology programs for both the USN and USMC by organizing, executing, and sponsoring broad investments in basic and applied research applicable to these Services.[342] Inside ONR, there are three programs furthering neuro S&T. First is the Auditory Neuroscience and Performance program, with a goal "to understand, prevent, and mitigate factors that negatively impact

340 Source: *Solid State Active Denial Technology*, January 30, 2014, YouTube, video, 3:20, https://www.youtube.com/watch?v=kn70PGq1KpI.

341 "Center for Military Psychiatry and Neuroscience," WRAIR, accessed August 12, 2021, https://www.wrair.army.mil/biomedical-research/center-for-military-psychiatry-and-neuroscience.

342 "About the Office of Naval Research," ONR, accessed August 12, 2021, https://www.onr.navy.mil/About-ONR.

warfighters' auditory performance," which includes acoustic weapons.[343] Second is the Cognitive Neuroscience of Perception and Attention program, with a goal "to elucidate the computational neurocognitive roles of attention and other top-down control mechanisms evident in mammalian vision and audition," in order to better understand and analyze complex, real world events.[344] Finally, the Computational Neuroscience program "aims to extract the computational principles of real neural circuits and systems to create novel, more powerful algorithms for pattern recognition and control," with the ultimate goal being "to develop brain-based intelligent systems that can be embedded into autonomous platforms and robots," or further BCI concepts.[345]

4. U.S. Marine Corp (USMC)

The Joint Intermediate Force Capabilities Office (JIFCO), which officially falls under the DOD Non-Lethal Weapons Program (NLWP) and reports to the Commandant of the Marine Corps, has a goal to facilitate non-lethal weapons (NLW) development and coordinate/integrate across the Services.[346] Many of the NLWs use DE in various forms and functions, which can have damaging effects on the brain. NLWs are relevant across the competition continuum and across all phases of warfare due to their ability to produce relevant effects without destruction of infrastructure or undesired casualties, which causes problems in the information space due to negative public opinion both within the immediate area and across the international community.[347] Numerous NLWs exist on land, at sea, and in the air,

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343 "Programs - Auditory Neuroscience & Performance," ONR, accessed August 12, 2021, https://www.onr.navy.mil/Science-Technology/Departments/Code-34/All-Programs/warfighter-protection-applications-342/auditory-neuroscience.

344 "Programs - Cognitive Neuroscience of Perception and Attention," ONR, accessed August 12, 2021, https://www.onr.navy.mil/Science-Technology/Departments/Code-34/All-Programs/human-bioengineered-systems-341/cognitive-neuroscience-of-perception-and-attention.

345 "Programs - Computational Neuroscience," ONR, accessed August 12, 2021, https://www.onr.navy.mil/Science-Technology/Departments/Code-34/All-Programs/human-bioengineered-systems-341/computational-neuroscience.

346 JIFCO, "History," U.S. DOD NLWP, accessed August 12, 2021, https://jnlwp.defense.gov/About/History/.

347 Law, "Directed Energy (DE) Intermediate Force Capabilities (IFCs): Relevant Across the Range of Military Operations," 4.

and could serve as the architecture for neuro-based effects.[348] There are many operational vignettes that demonstrate their utility to current and future military operations.[349]

5. U.S. Special Operations Command (USSOCOM)

USSOCOM has been and will continue to be on the leading edge of neuro S&T research, especially for cognitive enhancement. In 2013, USSOCOM sought to establish a Center of Excellence in Operational Neuroscience through a partnership at Yale University with a goal to use neuroscience to provide a tactical advantage to military members in the field.[350] However, it was cancelled before even starting after outcry due to ethical concerns of militarizing neuroscience research.

In 2016, when then-SecDef Ash Carter gave a speech opening up the Defense Innovation Unit Experimental (DIUx) in Cambridge, he highlighted a partnership with a neuro S&T company called Halo Neuroscience:

> They've invented a wearable device that looks like a pair of headphones and uses non-invasive electrical stimulation to increase the brain's natural ability to adapt to training. These headsets will be used by teams from our special operations forces who will work with Halo to gauge how effective their device might be to improving marksmanship, close-quarters combat skills and overall strength training.[351]

Due to the nature of SOF taskings and missions, involving small numbers, isolated, and needing to adapt to dynamic and complex environments, SOF has a desire to invest heavily in cognitive enhancement R&D. These ideas form the foundation for USSOCOM's HEO concept, unveiled in 2019, which focuses on cognitive enhancements in order to think

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348 Law, 8.

349 Law, 10–12.

350 Roy Eidelson, "Neuroscience, Special Forces, and Ethics at Yale," *Psychology Today*, March 6, 2013, https://www.psychologytoday.com/za/blog/dangerous-ideas/201303/neuroscience-special-forces-and-ethics-yale.

351 Ash Carter, "Remarks On Opening DIUx East and Announcing the Defense Innovation Board" (Cambridge, MA, July 26, 2016), https://www.defense.gov/Newsroom/Speeches/Speech/Article/858155/remarks-on-opening-diux-east-and-announcing-the-defense-innovation-board/.

better and faster.[352] As previously mentioned, SOF AT&L defines the HEO as "leveraging next-generation capabilities, linked together as a synchronized system with advanced human-machine interface, the HEO has improved human performance and decision-making through integrated hardware and software solutions of combined systems."[353] In a Small Wars Journal article about HEO it is defined as "a SOF professional empowered by technologies that enhance the operator's cognition at the edge by increasing situational awareness, reducing cognitive load, and accelerating decision making."[354] Due to the uncertain and fluid conditions and missions that SOF is tasked to perform, they require a higher level of physical and cognitive performance in order to succeed. To be clear, there are many aspects to HEO and enhancing cognition is just one part; however, specific details about the capabilities being developed are not open to the public domain. In theory, advancements in neuro S&T has the potential to create "super soldiers," with increased cognitive, behavioral, and emotional capacities to outwit threats and perform better under stress. Such soldiers could ultimately "be more effective in reducing the risk of violence."[355]

The same advancements that add value for cognitive enhancement also pose risks when used for cognitive degradation. USSOCOM is leading the DOD in seeking answers to many of the questions brought on by neuroweapons and the weaponization of neuroscience. The Joint Special Operations University (JSOU) put out a call for research in 2020 under the 'Innovation for Future Threats' topic area to discuss the potential implications of neuroweapons on the force, including the commercial-off-the-shelf (COTS) technology available to adversaries, the risk posed to SOF, and improving detection and mitigation of neuro threats.[356] Clearly, USSOCOM is taking the future of neurowarfare very seriously.

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[352] Alex MacCalman et al., "The Hyper-Enabled Operator," *Small Wars Journal*, June 6, 2019, https://smallwarsjournal.com/jrnl/art/hyper-enabled-operator.

[353] SOF AT&L, "Our Organization."

[354] MacCalman et al., "The Hyper-Enabled Operator."

[355] Giordano, "Weaponizing the Brain."

[356] JSOU, "Special Operations Research Topics 2020" (MacDill Air Force Base, Florida: The JSOU Press, 2019), https://www.usmcu.edu/Portals/218/SchoolFiles/JSOU19a-2020Research-Topics-Final.pdf?ver=2019-08-22-124232-560.

6. Defense Health Agency (DHA)

The DHA is "a joint, integrated Combat Support Agency that enables the Army, Navy, and Air Force medical services to provide a medically ready force and ready medical force to Combatant Commands in both peacetime and wartime. The DHA supports the delivery of integrated, affordable, and high quality health services to Military Health System (MHS) beneficiaries and is responsible for driving greater integration of clinical and business processes across the MHS."[357] In essence, DHA is responsible for the delivery and management of preventative, routine, and long-term healthcare to beneficiaries, and therefore were tasked with leading the effort for vigilance against DEWs. Interestingly, DHA has a SBIR request to "develop a low cost, low weight, small size wearable RF weapon exposure detector."[358] Currently, this is the only known endeavor towards developing preventive measures and protective equipment to shield warfighters. More attention and broader awareness will spark innovation and competition.

D. CONCLUSION

This appendix highlighted recent progress by U.S. national security organizations in delivering the first iteration of neuro S&T programs. Based on the wide-ranging and cutting-edge work that many important institutions are doing in neuro S&T, including government agencies, DARPA, IARPA, the Military Services, and USSOCOM, it should be clear from the discussion that future technological breakthroughs may revolutionize and alter human society, human consciousness, and war, even leading to a new domain of warfare.[359]

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357 "Defense Health Agency," Health.mil, accessed August 17, 2021, https://health.mil/About-MHS/OASDHA/Defense-Health-Agency.

358 "Wearable Radio Frequency Weapon Exposure Detector," SBIR.gov, accessed July 15, 2021, https://www.sbir.gov/node/1841633.

359 Krishnan, *Military Neuroscience and the Coming Age of Neurowarfare*, 1.

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