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Attack on the Brain: Neurowars and Neurowarfare

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Is neurotechnology leading nation-states toward a new domain of war?

Neuroscience is on the verge of deciphering the human brain.[1] As a result, brains will become a part of the battlefield against which attacks will be directed.[2] As neuroscientist James Giordano argued: "the brain is the next battlespace."[3] It is foreseeable that this will have tremendous implications for warfare and could amount to a true military revolution in the sense of military historian Williamson Murray: it would completely change the characteristics of conflict, as well as transform state and society.[4]

Neuroscience will lead to the development of 'neuroweapons,' which can remotely manipulate mental states, emotions, perceptions, thinking, and behavior of adversaries. As argued by Vladimir Putin, "[s]uch high-tech weapons systems will be comparable in effect to nuclear weapons, but will be more acceptable in terms of political and military ideology."[5] In a coming age of neurowarfare traditional military conflict may no longer take place or may become ancillary to the goal of psychologically manipulating or subverting enemy leaders and even entire societies. States and other actors could be coerced with no resort to open violence and conflicts could be suppressed before they can ever break out. At the same time, neurotechnologies and sophisticated methods of psychological influencing could also be used offensively against enemy societies with the goal of "collapsing the enemy internally rather than physically destroying him."[6] In the worst case, neuroscience and neurotechnolgies (neuro S/T) could be abused for torture, genocide, and high-tech repression. The ethical implications of brain and mind manipulation are inescapable and would require a wider debate.

However, the purpose of this paper is to introduce the concept of neurowarfare in its two basic meanings: 1) the application of neuro S/T to warfare and security and 2) neurowarfare as war in 'neurospace', an emerging and distinctive domain of war, where combat may take place and victory may be achieved. The paper will therefore outline some of the neuro S/T applications relevant to war and conflict. Secondly it will sketch and define the new emerging domain of war. Finally, it is argued that a neurowarfare strategy is needed for coming to terms with issues relating to targeting, deterrence, and threshold to war, before neuroweapons are introduced.

MILITARY NEUROSCIENCE

Military brain and behavioral research goes back to at least the 1920s and dramatically expanded in the U.S. in the 1950s because of the desire to understand Communist brainwashing and to develop methods that surpassed those of the Communist mind programmers. The Artichoke/ MK ULTRA documents of the early 1950s to the early 1960s leave no doubt that the CIA and the U.S. military aimed for the hypnotic

[1] Armin Krishnan is Assistant Professor for Security Studies, East Carolina University, Greenville, NC.
[2] Laura Sanders, "Brains May Be War's Battlegrounds," *Science News* 180 (2011): 14.
[3] Tim Requarth, "This Is Your Brain. This Is Your Brain as a Weapon," *Foreign Policy* (September/ October), http://foreignpolicy.com/2015/09/14/this-is-your-brain-this-is-your-brain-as-a-weapon-darpa-dual-use-neuroscience/ (accessed September 18, 2015).
[4] Williamson Murray, "Thinking about Revolutions in Military Affairs," *Joint Forces Quarterly* (Summer 1997): 71.
[5] Christopher Leake and Will Stewart, "Putin Targets Foes with 'Zombie' Gun Which Attacks Victim's Central Nervous System," *The Daily Mail*, March 31, 2012, http://www.dailymail.co.uk/news/article-2123415/Putin-targets-foes-zombie-gun-attack-victims-central-nervous-system.html (accessed September 8, 2015).
[6] William S. Lind, Keith Nightengale, John F. Schmitt, Joseph W. Sutton, and Gary I. Wilson, "The Changing Face of War: Into the Fourth Generation," *Marine Corps Gazette* 73 (1989): 23.

and physical control of enemy minds, both in the context of intelligence operations as well as in 'psychochemical' warfare operations directed against entire societies.[7] Although these efforts were apparently not particularly successful, there has been since 2001 in the aftermath of 9/11 a renewed interest by DARPA and other agencies to develop and leverage brain research for the national security sector. This was also encouraged by new brain imaging technology developed and perfected in the 1990s, such as fMRIs, that have given neuroscientists unprecedented insights into the processes occurring inside a living human brain.

Bioethicist Jonathan Moreno drew attention to the topic of military neuroscience through his 2006 book *Mind Wars*, which also discussed some of the related ethical issues.[8] Since then the DIA commissioned a National Research Council study on military applications of neuroscience research in 2008 and the U.S. Army commissioned another study on neuroscience opportunities for the Army in 2009.[9] This was followed by a Royal Society study on *Neuroscience, Conflict and Security* published in 2012.[10] These studies mostly highlighted potential contributions of neuro S/T to human enhancement, strategic intelligence, security and interrogation, and neuroscientific methods of influencing an adversary. In 2013 Special Operations Command (SOCOM) announced the creation of a *Center for Excellence in Operational Neuroscience* at Yale University, which did not go ahead because of the controversy over using neuroscience research for interrogation and the 'ethical risks' inherent to such research.[11]

However, it is mostly civilian academic and commercial research that is currently driving the advancement of neuroscience. President Obama announced the American BRAIN Initiative in April 2013 that aims to revolutionize our understanding of the brain. The President explained that it will be a long-term scientific effort comparable to the human genome project and that it could impact "the lives of not millions, but billions of people on this planet."[12] The plan is to spend $100 million dollars in federal money and $200 million dollars in private sector money on neuroscience research for ten years. The project will be led by the National Institutes of Health, the National Science Foundation, and DARPA in conjunction with private sector partners such as the Allen Institute for Brain Science, the Howard Hughes Medical Institute, the Kavli Foundation, and the Salk Institute for Biological Studies.[13] According to the White House:

> The BRAIN Initiative will accelerate the development and application of new technologies that will enable researchers to produce dynamic pictures of the brain that show how individual brain cells and complex neural circuits interact at the speed of thought. These technologies will open new doors to explore how the brain records, processes, uses, stores, and retrieves vast quantities of information, and shed light on the complex links

[7] U.S. Congress, "Project MKULTRA, the CIA's Program of Research in Behavioral Modification," Joint Hearing Before the Select Committee on Intelligence and the Subcommittee on Health and Scientific Research of the Committee on Human Resources, United States Senate, Ninety-Fifth Congress, August 3, 1977, Appendices, pp. 65-171.
[8] Jonathan Moreno, *Mind Wars: Brain Research and National Defense* (New York: Dana Press, 2006).
[9] National Research Council, *Emerging Cognitive Neuroscience and Related Technologies* (Washington, DC: National Academies Press, 2008); National Research Council, *Opportunities in Neuroscience for Future Army Applications* (Washington, DC: National Academies Press, 2009).
[10]; Royal Society, *Brain Waves Module 3: Neuroscience, Conflict and Security* (London: The Royal Society, 2012).
[11] Roy Eidelson, "Neuroscience, Special Forces and Yale," *Counterpunch*, March 6, 2013, http://www.counterpunch.org/2013/03/06/neuroscience-special-forces-and-yale/ (accessed August 28, 2015).
[12] White House, "Fact Sheet: BRAIN Initiative," *Press Release*, April 2, 2013, https://www.whitehouse.gov/the-press-office/2013/04/02/fact-sheet-brain-initiative (accessed August 28, 2015).
[13] T.R. Insel, S.C. Landis, and F.S. Collins, "The BRAIN Initiative," *Science* 340 (2013): 687-688.

between brain function and behavior.[14]

This neuroscience funding comes on top of the normal research funding in related disciplines and commercial research funded by major corporations in the health and IT/ communications sectors. The great importance of private sector research is indicated by the tremendous growth in neuroscience patents that are mostly filed by corporations. In 2010 alone 800 neurotechnology patents have been filed – a doubling of patents per year from the previous decade. Interestingly, most patents were filed by the marketing research company Nielsen (100) and by software giant Microsoft (89), which shows that neurotechnology has already gone beyond medical applications and is poised to proliferate across society.[15]

Similar efforts of 'unlocking the brain' are underway across the world. For example, the European Union has inaugurated a similar neuroscience research effort called the Human Brain Project (HBP) in October 2013. The EU pledged to spend €1 billion euros over ten years to "gain fundamental insights into what it means to be human, develop new treatments for brain diseases, and build revolutionary new Information and Communications Technologies (ICT)."[16] Canada has joined the race with an announcement of dedicating $100 million dollars over five years to brain research.[17] In 2014 Japan launched the Brain/ MINDS Initiative, which also seeks to map the brain.[18] Overall, it has been estimated that public and private sector neuro S/T investment is around $150 billion annually worldwide.[19] Most worryingly, it is projected that Asia and South America will outspend the United States and its western allies by 2020.[20] Neuro S/T could proliferate to nonstate actors, including criminal organizations, terrorist groups, and even individuals, and may result in novel security and criminal threats.[21]

What follows is an overview of some of the applications and technologies that have the greatest potential for usage in war and conflict. It is important to keep in mind that neuro S/T has numerous civilian applications, ranging from medical/ health applications to recreation and enhancement to name a few. The technology will spread quickly across societies and create like the Internet a new arena or battleground where conflict will take place. The *Royal Society* report suggested dividing military applications of neuro S/T into two primary types: performance enhancement and performance degradation, which will be used, here, as a basic structure.[22] Of course, all enhancement technologies can be in principle also used for degradation.

ENHANCEMENT TECHNOLOGIES

A major UK Ministry of Defence assessment of global trends speculated that "A range of technological enhancements have the potential to transform human identity by improving sensory perception, physical performance and perhaps even giving us the ability to control fear and other emotional

[14] White House, "Fact Sheet."
[15] A. Griffin, "Patents for Technology to Read People's Minds Hugely Increasing," *The Independent*, May 8, 2015, http://www.independent.co.uk/life-style/gadgets-and-tech/news/patents-for-technology-to-read-peoples-minds-hugely-increasing-10236211.html (accessed August 28, 2015).
[16] Henry Markram, "The Human Brain Project: A Report to the European Commission," Human Brain Project, April 2012, https://www.humanbrainproject.eu/documents/10180/17648/TheHBPReport_LR.pdf/18e5747e-10af-4bec-9806-d03aead57655 (accessed August 28, 2015).
[17] "Ontario Leading Brain Research," Office of the Prime Minister, Press Release, March 5, 2013, http://news.ontario.ca/opo/en/2013/03/ontario-leading-brain-research.html (accessed December 12, 2014).
[18] Requart, "This Is Your Brain."
[19] 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, http://carnegieendowment.org/files/U_NeuroDeterrence_Workshop_Approved_for_Public_Release_31Jan14v2.pdf (accessed November 6, 2014).
[20] Ibid.
[21] M. Goodman, *Future Crimes: Everything Is Connected, Everything Is Vulnerable and What We Can Do About It* (New York: DoubleDay, 2015), pp. 261-288.
[22] Royal Society, *Brainwaves Module 3*: III.

states."[23] In the future, military commanders may have the ability to monitor and control the mental states of their soldiers, who may be able through enhancements to perform well without rest for days, to manage their emotions under stress, and to respond faster and smarter to emerging threats. There are three basic approaches to enhancement that seem to be particularly promising: neuropharmacology, brain stimulation, and brain-computer interfaces. It seems a foregone conclusion that enhancement technologies would spread quickly beyond the military and across societies that emphasize competitiveness and individual achievement.

Neuropharmacology

Throughout history, militaries have drugged their soldiers to keep them happy, to master their fear, to keep them awake, and to make them better able to endure gruesome conditions. Most militaries used alcohol, caffeine, and nicotine, Yemeni and Somali tribesmen chewed khat, and Prussian soldiers were given cocaine in the late 19th century. The Nazis infamously put amphetamine under the brand name Pervitin into chocolate and handed them out to soldiers to make them fearless and more energetic, while Nazi leaders such as Hitler and Goering took amphetamines for better coping with the stress of decision-making in war.[24] The U.S. Air Force has handed out 'go pills' (e.g. Dexedrine) to pilots since World War II. The concept of military drug use for performance enhancement is therefore nothing new, but it has certainly become more controversial. In recent times there has been growing concern over the routine non-treatment medication of U.S. soldiers, which has already resulted in some tragic lapses of judgment, apart from the other obvious problems associated with the long-term use of pharmaceuticals such as addiction and permanent damage to the soldiers' health.[25]

The hope is that neuroscience will develop new drugs that are both far more effective and also safer than the ones that currently exist, which would also make the medication of soldiers with psychotropic drugs more acceptable. Neuroscientists have gained over the last decades an excellent understanding of brain chemistry, which has already led to the development of many new psychotropic drugs such as Prozac, first approved by the FDA in 1987. Researchers hope to not only cure depression, PTSD, and other mental disorders but to ultimately enhance mental capabilities through so-called nootropic drugs and special nutrition that can improve memory, cognitive functions, motivation, and attention.[26] Better computer models based on new methods of neuroimaging could enable researchers to better predict the effects of certain drugs on the brain. Greater precision of drug delivery to specific areas of the brain could also produce very precise psychological and behavioral effects. Nanotechnologies could deliver drugs across the blood-brain barrier and make drugs more effective.[27]

One particular cognitive enhancement drug that is currently being reviewed by several militaries around the world is modafinil. The drug has already been approved by the FDA for treating narcolepsy and sleep disorders (known under the brand name Provigil). What makes modafinil especially interesting for armed forces is its feature of improving alertness and wakefulness instead of merely suppressing tiredness.[28] Other drugs could reduce stress or anxiety and make it thereby also less likely that soldiers will suffer from PTSD at some later point. Roger Pitman from Harvard University uses the beta-blocker propranolol for suppressing the formation of painful memories of veterans.[29] Soldiers could be

[23] "Global Strategic Trends – Out to 2045," London, UK Ministry of Defence, 2014, p. 83.
[24] Mick Farren, *Speed-Speed-Speedfreak: A Fast History of Amphetamine* (Port Townsend, WA: Feral House, 2010), pp. 22-51.
[25] Kim Murphy, "A Fog of Drugs and War," *Los Angeles Times*, April 7, 2012, http://articles.latimes.com/2012/apr/07/nation/la-na-army-medication-20120408 (accessed December 29, 2014).
[26] Kenneth Ford and Clark Glymour, "The Enhanced Warfighter," *The Bulletin of Atomic Scientists* 1 (2014): 43-53.
[27] National Research Council, *Emerging Cognitive Neuroscience and Related Technologies*, p. 5.
[28] Richard Martin, "It's Wake-Up Time," *Wired* 11.11, November 2003, http://archive.wired.com/wired/archive/11.11/sleep_pr.html (accessed December 12, 2014).
[29] Moreno, *Mind Wars*, p. 152.

medicated through implanted chips that release a variety of drugs directly into the brain and the drug release could be activated in response to a measured brain state or through a wireless remote signal. A Massachusetts company has already patented such a drug release chip that can be inserted through a tiny whole in the skull via a syringe.[30]

Brain Stimulation

The idea of electrical brain stimulation for therapeutic purposes is also not new. Medical doctors and psychiatrists have used the electrical stimulation of the brain for treating mental illnesses since the 18th century, with electrotherapy becoming popular in psychiatry in the late 19th century.[31] The modern electroconvulsive therapy, in which an electrical current is applied to the brain through electrodes, has been widely used since the 1940s and 1950s. Despite its frequent portrayal as a cruel form of treatment in popular culture, the American Psychiatric Association considers it safe and effective for treating major depression, schizophrenia, and bipolar disorders.[32] Since the early 1980s psychiatrists have developed newer methods for electrically stimulating the brain.

The Transcranial Magnetic Stimulation (TMS) method applies strong electromagnetic fields of thousands of volts through a helmet-like device above the brain to activate specific brain regions. TMS has shown promise in terms of treating depression and other mental disorders, but there are still some concerns for the safety of the treatment.[33] TMS might improve cognitive functions, alleviate pain, and reduce the need for sleep. TMS has been demonstrated to enable external control of a person's hand movements by stimulating the motor cortex and to enable the transmission of simple information encoded in Morse code directly into the brain.[34] The downside of TMS is that it requires a large coil and power source, which are difficult to miniaturize and to make portable. TMS can also not reach deeper areas of the brain and may therefore only have some limited medical applications.

Other brain stimulation methods include transcranial Direct Current Stimulation (tDCS) and Transcranial Pulsed Ultrasound Stimulation: both might be suitable for integration into a soldier's combat helmet and are therefore of particular interest to the military. tDCS applies a weak current through electrodes to the scalp, which has shown to significantly increase concentration and cognitive capabilities in test subjects.[35] The U.S. Air Force has already tested "external stimulant technology to enable the airman to maintain focus on aerospace tasks and to receive and process greater amounts of operationally relevant information" and has found that "it can help pilots better pick out targets from radar images."[36]

Researchers from Arizona State University are already working on a Transcranial Pulsed Ultrasound device that can be fitted into a helmet and that could be used for controlling the mental

[30] Rob Matheson, "Deal Reached to Commercialize Microchip Drug-Delivery Implant," *Tech Swarm*, June 29, 2015, http://www.techswarm.com/2015/06/deal-reached-to-commercialize-microchip.html (accessed August 28, 2015).
[31] Adam Keiper, "The New Age of Neuroelectrics," *The New Atlantis*, 2006 (Winter): 6.
[32] Robert H. Blank, *Intervention in the Brain: Politics, Policy, and Ethics* (Cambridge, MA: MIT Press), p. 27.
[33] Ibid.: 30.
[34] R. Rao, A. Stocco, M. Bryan, D. Sarma, T.M. Youngquist, J. Wu and C.S. Prat, "A Direct Brain-to-Brain Interface in Humans," *PLOS One* 10.137 (2014); C. Grau, R. Ginhoux, A. Riera, T.L. Nguyen, H. Chauvat, M. Berg, J.L. Amengual, A. Pascual-Leone and G. Ruffini, "Conscious Brain-to-Brain Communication in Humans Using Non-Invasive Technologies," *PLOS One* 10.1371 (2014).
[35] Gary E. Marchant and Lyn M. Gaudet, "Neuroscience, National Security, and the Reverse Dual-Use Dilemma," in James Giordano, *Neurotechnology in National Security and Defense* (Boca Raton, FL: CRC Press 2014), p. 172.
[36] Noah Shachtman, "Air Force Wants Neuroweapons to Overwhelm Enemy Minds," *Wired Blog*, November 2, 2010, http://www.wired.com/2010/11/air-force-looks-to-artificially-overwhelm-enemy-cognitive-capabilities/ (accessed December 29, 2014); "Brain Hacking Is Having Incredible Effects and It Is Just Getting Started," *Business Insider*, August 16, 2014, https://www.yahoo.com/tech/brain-hacking-is-having-incredible-effects-and-its-94844111639.html (accessed December 29, 2014).

states of soldiers, boosting alertness, and relieving pain from injuries.[37] The pulsed ultrasound would be also able to reach deeper regions of the brain. Brain stimulation methods could have numerous benefits in terms of treatment and enhancement for people across society, and the technology could spread very quickly as indicated by the great commercial success of a tDCS device called Foc.us that is being marketed as a 'gaming device.'[38]

Brain-Computer Interfaces

The ultimate goal in the development of neural devices is to build a brain-computer interface that enables a person to receive information from a computer or device, as well as transmit information from the brain to a computer either as a computer input device or for controlling machinery. Primitive BCIs already exist. They come in two varieties: invasive BCIs that require implanting an electrode or chip into the brain and non-invasive BCIs that rely on measurements taken from outside the head.

The great pioneer of BCIs was Yale scientist Jose Delgado, who implanted animals and also some humans with a device he called 'stimoceiver' in the late 1960s. The stimoceiver enabled Delgado to very reliably trigger behaviors bypassing conscious decision-making by electrically stimulating a particular area of the brain, although he admitted that the method was generally incapable of programming new behaviors.[39] Of course, invasive methods as used by Delgado are ethically highly controversial: they could permanently affect human personality and require medically risky procedures. For this reason invasive BCIs can currently only be considered for purely therapeutical purposes that treat an existing medical condition. For example, currently under development by DARPA is Deep Brain Stimulation (DBS) based on implanted microchips that function as pacemakers for the brain of Parkinson's disease patients and for individuals suffering from PTSD. About 100,000 patients have up to now received DBS implants, and DARPA has recently made $70 million dollars available for further research into DBS.[40] Another example is neuroprosthetics, in particular those implants that restore lost sensory abilities such as cochlea and retinal implants or that enable neural control over robotic prostheses.

The current focus of BCI research is on non-invasive BCIs that are small, transportable, and low-cost. In particular, two approaches seem most promising in this respect: Functional Near-Infrared Spectroscopy (FNIRS), which measures changes in brain tissue associated with neuronal activity, and Electroencephalography (EEG), which measures fluctuations of voltage on the scalp. EEGs are more popular with researchers, who have used them in a variety of ways. It has already been demonstrated that equipped with an EEG a paralyzed person can move a cursor on a screen by simply imagining the movement beforehand.[41] For example, a monkey could operate a robotic arm through a BCI to get food.[42] There are many applications for this technology. Major IT companies such as Google and Intel are working on BCIs as new computer input devices, making mouse and keyboard obsolete as early as

[37] Clay Dillow, "DARPA Wants to Install Ultrasound Mind Control Devices in Soldiers' Helmets," *Popular Science*, September 9, 2010, http://www.popsci.com/technology/article/2010-09/darpa-wants-mind-control-keep-soldiers-sharp-smart-and-safe (accessed November 6, 2014).

[38] Kate Murphy, "Jump-Starter Kits for the Mind," *The New York Times*, October 28, 2013, http://www.nytimes.com/2013/10/29/science/jump-starter-kits-for-the-mind.html?_r=0 (accessed December 12, 2014).

[39] This is described in his book: Jose Delgado, *Physical Control of the Mind* (New York: Harper & Row Publishers, 1969).

[40] James Gorman, "Agency Initiative Will Focus on Advancing Deep Brain Stimulation," *The New York Times*, October 24, 2013, http://www.nytimes.com/2013/10/25/science/pentagon-agency-to-spend-70-million-on-brain-research.html?_r=0 (accessed December 29, 2014).

[41] Jeremiah D. Wander et al., "Distributed Cortical Adaptation during Learning of a Brain-Computer Interface Task," *Proceedings of the National Academy of Sciences* 110 (2013): 10818-10823.

[42] Ian Sample, "Monkeys Use Mind Control to Move a Virtual Arm and Experience Touch," *The Guardian*, October 5, 2011, http://www.theguardian.com/science/2011/oct/05/monkeys-mind-control-virtual-arm (accessed January 2, 2015).

2020.[43] An Air University dissertation claims "[i]t is likely that BCI technology will dominate military systems in 2032."[44]

A much more ambitious goal is to build a mind reading device that can translate actual thoughts in a manner that a computer can understand them. For example, one could measure and catalogue EEG responses to specific words and simply match brain activity to thoughts. Such research is indeed undertaken by scientists at the University of California, Irvine. Researcher Mike D'Zmura believes that it would take 15 to 20 years to develop thought-based communication.[45] Special Operations Forces soldiers use the technology to silently and efficiently communicate with each other just by thinking (hence the project name 'synthetic telepathy'). Neuroscientist Thomas Naselaris opined that "[t]he potential to do something like mind reading is going to be available sooner rather than later…It's going to be possible in our lifetimes."[46] Although the Royal Society report claims that "[t]here are very limited prospects for a universal thought reading machine," because of the uniqueness of each brain and the brain's general plasticity (tendency to change over time), the technology does at the very least raise some concerns about the prospect of new weapons systems with direct neurological control.[47]

The potential advantage of BCI-controlled weapons is that they could immerse soldiers better in the battlespace when remotely controlling an unmanned system for better situational awareness. BCIs could also significantly improve threat detection and identification accuracy, as well as substantially reduce human response times.[48] In particular, DARPA is developing the 'Cognitive Technology Threat Warning System' (CT2WS), which uses an EEG that detects unconscious brain responses to potential threats appearing on a monitor and flags them to the operator. Via BCI, soldiers will be better able to control complex machinery such as robotic exoskeletons or unmanned systems. This kind of research has already stimulated a heated debate on the legality of 'neuroweapons' based on using a soldier's brain processes as input for detecting a threat and activating a weapon without requiring a conscious decision on the part of the soldier whose brain has been wired to the weapons.[49]

DEGRADATION TECHNOLOGIES

While enhancement seems to offer exciting opportunities for gaining an advantage by making soldiers smarter, they are also more speculative. As a rule of thumb, enhancement tends to be much more difficult than degradation. However, enhancement is at the focus of the academic literature since much of it is developed more or less openly while degradation methods such as more exotic nonlethal weaponry are often portrayed as fictional or aspirational. FAS researcher Steven Aftergood has mocked the Pentagon over its excessive secrecy in this respect, suggesting that it could allow little more

[43] Nick Bilton, "Disruptions: Brain-Computer Interfaces Inch Closer to Mainstream," *The New York Times*, April 6, 2013, http://bits.blogs.nytimes.com/2013/04/28/disruptions-no-words-no-gestures-just-your-brain-as-a-control-pad/?_r=0 (accessed December 29, 2014); Sharon Gaudin, "Intel: Chips in Brains Will Control Computers by 2020," *ComputerWorld*, November 19, 2009, http://www.computerworld.com/article/2521888/app-development/intel--chips-in-brains-will-control-computers-by-2020.html (accessed December 29, 2014).

[44] Brian E. Moore, "The Brain-Computer Interface Future: Time for a Strategy," Research Report, Air University, February 14, 2013.

[45] Eric Bland, "Army Developing 'Synthetic Telepathy,' " *NBC News*, October 13, 2008, http://www.nbcnews.com/id/27162401/ns/technology_and_science-science/t/army-developing-synthetic-telepathy/#.VEF0x2es_8U (accessed November 6, 2014).

[46] Requarth, "This Is Your Brain."

[47] Royal Society, *Brain Waves Module 3*, pp. 16, 20.

[48] "Weapons of Perception: Neuroscience and Mind-Controlled Weapons," *Army-Technology.com*, May 22, 2012, http://www.army-technology.com/features/featureweapons-of-perception-neuroscience-mind-controlled-weapons-and-the-military/ (accessed November 6, 2014).

[49] Stephen White, "Brave New World: Neurowarfare and the Limits of International Humanitarian Law," *Cornell International Law Journal* 41 (2008): 194-196.

than mumbo jumbo to prosper in the closed off world of black projects.[50]

The reality of secret nonlethal weapons is probably more complex. Regardless of what may or may not exist at the present time, there is clearly a potential for future neuroscience-based nonlethal weapons that could be best described as 'neuroweapons' (sometimes referred to as 'RF weapons', 'psychotronic weapons', or 'influence weapons'). Robert McCreight suggests the following definition: "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."[51] These weapons generally target the human brain and the central nervous system; they can impact on mental and emotional states, mental capacity and response times, and potentially higher cognitive functions supporting thought, perception, memory, and learning. These effects could be achieved through a variety of means: biochemical agents, directed energy weapons (DEW), and even information/software (going beyond normal PSYOPS).

Biochemical Agents

Most of the publicly available information about offensive neuroweapons currently relates to the potential use of biochemical agents as incapacitants and potentially for otherwise influencing the behavior of an adversary. While chemical and biological warfare are internationally outlawed, there are several legal gaps that could allow the usage of biochemical neuroweapons in specific contexts. A frequently cited case is the use of the opioid fentanyl by the FSB during the Moscow theater siege in October 2002. The chemicals were intended to put the Chechen terrorists to sleep, which also accidentally killed 128 hostages (out of over eight hundred) because of a delayed and wrong medical emergency response.[52]

Nevertheless, researchers have made the claim that biochemical calmatives and malodorants could play an important role in future conflicts as a nonlethal technique and could provide a humanitarian alternative to the use of lethal force.[53] Militaries around the world have shown interest in biochemical incapacitating agents for counter-insurgency and counterterrorism operations.[54] Biochemical incapacitants could be dispersed from the air or covertly introduced into the water and food supply to assist in winning 'the hearts and minds' and in neutralizing various threats within a population. This is in principle a very old idea that goes back at least to 1949 when 'psychochemical warfare' was proposed by Army Chemical Center scientist L. Wilson Greene.[55] There could be a range of new neuropharmaceuticals under development that could produce relatively predictable behavioral effects and could prove suitable even for large area psychochemical warfare attacks.

One biochemical agent that seems to have caught the interest of the military is the neurohormone oxytocin, which is naturally produced by the brain and stimulates love or trust. Oxytocin could be used for manipulating adversaries into (temporarily) trusting us and thereby reduce the

[50] Steven Aftergood, "The Soft-Kill Fallacy," *The Bulletin of Atomic Scientists* (September-October 1994): 40-45.

[51] Robert McCreight, "Brain Brinksmanship: Devising Neuroweapons Looking at Battlespace, Doctrine, and Strategy", in: James Giordano (ed.), *Neurotechnology in National Security and Defense: Practical Considerations, Neuroethical Concerns* (Boca Raton, FL: CRC Press, 2014), pp. 117-118.

[52] David A. Koplow, *Non-lethal Weapons: The Law and Policies of Revolutionary Technologies for the Military and Law Enforcement* (Cambridge: Cambridge University Press, 2006), pp. 100-112.

[53] Martin Furmanski, "Historical Military Interest in Low-Lethality Biochemical Agents: Avoiding and Augmenting Lethal Force," in Alan M. Pearson, Marie Isabelle Chevrier and Mark Wheelis, *Incapacitating Biochemical Weapons* (Plymouth, UK, Lexington Books, 2007), pp. 35-66.

[54] Alan Pearson, "Incapacitating Biochemical Agents: Science, Technology, and Policy for the 21st Century," *Nonproliferation Review* 13 (2006): 151-188.

[55] Raffi Khatchadourian, "Operation Delirium," *The New Yorker*, December 17, 2012, http://www.newyorker.com/magazine/2012/12/17/operation-delirium (accessed December 29, 2014).

occurrence of resistance.[56] Oxytocin is commercially marketed as 'Liquid Trust'. The U.S. military even investigated the possibility of a 'gay bomb', which was meant to distract enemy forces by inducing sexual arousal and disrupt morale.[57] Even a 'zombie bomb' is imaginable: the alkaloid drug scopolamine (also known by its street name burundanga) can put people exposed to it in a highly suggestible state, in which they lose their free will.[58] Bioethicist Jonathan Moreno seems to be also concerned about future 'brain targeted bioweapons' that could alter behavior. Genetic bioweapons have been a concern for some time, but a new nonlethal twist could be added to them. Microbiologists have recently discovered mind-controlling parasites that can manipulate the behavior of their hosts according to their needs by switching genes on or off.[59] Since human behavior is at least partially influenced by their genetics, nonlethal behavior modifying genetic bioweapons that spread through a highly contagious virus could thus be, in principle, possible.

Directed Energy Weapons (DEWs)

DEWs are no longer the stuff of science fiction, but have already been gradually transitioned to the battlefield.[60] They form a very broad class of weaponry, which includes any type of weapon that uses energy for producing a weapons effect, most importantly lasers, high-powered microwaves (non-nuclear EMP), high energy radio-frequency weapons, and also sound or acoustic weapons.

Although much of DEW research is secret, especially when it comes to antipersonnel DEWs, there are a couple of weapons systems that have been presented to the public and that are operational. For example, it is documented that it is possible to induce motion sickness, nausea, disorientation, and seizures through stroboscopic dazzling lights ('Bucha effect'), or to produce similar effects using certain acoustic or radio frequencies.[61] The Department of Defense (DoD) has developed various laser dazzlers that temporarily blind adversaries. Recently a company has patented a new type of stun gun that overstimulates the brain with bursts of lights and thereby disorients people for up to 20 minutes.[62] DoD has also developed acoustic weapons such as the Long Range Acoustic Device (LRAD) that can produce sounds that are still painful at distance of a hundred meters.[63] Another example is the Active Denial System (ADS), which uses microwaves of 95 GHz to create a burning sensation on the skin over a distance of at least 300 meters and which can force hostile crowds to disperse.[64]

Other antipersonnel DEWs are up to now more hypothetical. A frequently cited declassified Army document that summarizes some research into biological effects of nonlethal weapons indicates that microwaves could be used for transmitting sounds directly into brains (the so-called 'Frey-effect') or for causing pain or death when the brain is targeted due to the thermal effect of microwaves.[65] Jonathan Moreno also claims: "Electromagnetic waves may be used to disrupt an

[56] Giordano and Wurzman, "Neurotechnologies as Weapons in National Security and Defense," p. 59.
[57] "U.S. Military Pondered Love Not War," *BBC News Online*, January 15, 2005, http://news.bbc.co.uk/2/hi/4174519.stm (accessed October 25, 2014).
[58] Jose de Cordoba, "In Colombia, the Drug Burundanga Is Street Thugs' Weapon of Choice," *Wall Street Journal* (July 7, 1995): 1.
[59] Carl Zimmer, "Parasites Practicing Mind Control," *The New York Times* (August 28, 2014), http://www.nytimes.com/2014/08/28/science/parasites-practicing-mind-control.html (accessed December 29, 2014).
[60] John Antal, "Phasers on Stun: A Status Report on Directed Energy Weapons Programmes," *Military Technology* 7 (2011): 66-73.
[61] Timothy Thomas, "The Mind Has No Firewall," *Parameters* (Spring 1998): 84-92.
[62] Valerie Ross, "'StunRay,' a Light Weapon that Overstimulates the Brain," *Discover Magazine*, April 5, 2011, http://blogs.discovermagazine.com/sciencenotfiction/2011/04/05/stunray-a-light-weapon-that-overstimulates-the-brain/#.VKQxQ3stFZ4 (accessed December 29, 2014).
[63] Juliette Volcler, *Extremely Loud: Sound as a Weapon* (New York: The New Press, 2013), p. 104.
[64] Moreno, *Mind Wars*, p. 176.
[65] U.S. Army, "Bioeffects of Selected Nonlethal Weapons," http://www.metatexte.net/docs/index-6.html (accessed January 2, 2015).

enemy soldier's nervous system, to cause epileptic seizures, or to warm their body fluids as though they were inside a microwave oven."[66] In the 1980s animal experiments with directed energy weapons have shown promise in terms of affecting mental states (changing EEGs) and behavior.[67] The possibility of radio frequency (RF) weapons that target the brain has been discussed more openly back in the 1980s. References to them still appear in a few military publications and declassified documents, which suggests that research into this technology continues.[68] Analyst James Dunnigan claimed that there "are radio transmitters that jam and short-circuit the human nervous system. This temporarily disables people the radio beams are aimed at."[69]

Microwaves could also be used for inducing sensory hallucinations over distance. For example, a 'voice-of-good weapon' that projects voices directly into the heads of individuals in support of PSYOPS could be possible and has been referred to on a U.S. Army website.[70] It has been reported in the press that "previous research has shown that low-frequency waves or beams can affect brain cells, alter psychological states and make it possible to transmit suggestions and commands directly into someone's thought processes. High doses of microwaves can damage the functioning of internal organs, control behaviour or even drive victims to suicide."[71] In the future it might be possible to influence moods and mental capacity of people in a larger geographic area using the electromagnetic spectrum, and thus induce passive, peaceful, riotous, or any other desirable behavior.

Information/ Software Based Neuroweapons

Not all neuroweapons need to be of a physical nature – some might just consist of information that is designed to manipulate behavior or there could be software that hacks neural devices or implanted chips. DARPA has within its Biological Technologies Office a neuroscience-based project called Narrative Networks, which aims "to understand how narratives influence human cognition and behavior, and apply those findings in international security contexts."[72] The context for national security is to understand why certain narratives are believed and others not and how narratives can support terrorism. The methods include research into how the brain responds to certain narratives and the development of computer models of how narratives affect individuals and social networks.

A related effort is the Minerva Initiative, which "seeks to build deeper understanding of the social, cultural, and political dynamics that shape regions of strategic interest around the world."[73] Another project is the Sentient World Simulation, which can simulate the behavior of entire societies and thereby enable wargaming of PSYOPS.[74] DARPA

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[66] Jonathan Moreno, *Undue Risk: Secret State Experiments on Humans* (New York: W.H. Freeman & Co., 2000), p. 289.

[67] Douglas Pasternak, "Wonder Weapons: The Pentagon's Quest for Nonlethal Arms is Amazing," *U.S. News and World Affairs* (June 29, 1997): 38-46.

[68] E.g., Paul E. Tyler, "The Electromagnetic Spectrum in Low-Intensity Conflict," in David J. Dean (ed.), *Low- Intensity Conflict and Modern Technology* (Montgomery, AL: Air University Press, 1986), pp. 249-260; Thomas, "The Mind Has No Firewall"; Dennis M. Bushnell, "Future Strategic Issues/ Future Warfare [Circa 2025]," NASA Langley Research Center, 2001, pp. 49-50.

[69] James F. Dunnigan, *Digital Soldiers: The Evolution of High-Tech Weaponry and Tomorrow's Brave New Battlefield* (New York: St. Martin's Press, 1996), p. 223.

[70] Sharon Weinberger, 'The Voice-of-God Weapon Returns', *Wired Blog*, December 21, 2007, http://www.wired.com/2007/12/the-voice-of-go/ (accessed November 6, 2014).

[71] Christopher Leake and Will Stewart, "Putin Targets Foes with 'Zombie' Gun Which Attacks Victims' Central Nervous System," *Daily Mail Online*, March 31, 2012, http://www.dailymail.co.uk/news/article-2123415/Putin-targets-foes-zombie-gun-attack-victims-central-nervous-system.html#ixzz2DPaQUNBO (accessed January 2, 2015).

[72] DARPA, "Narrative Networks," Biological Technologies Office/ DARPA, http://www.darpa.mil/Our_Work/BTO/Programs/Narrative_Networks.aspx (accessed October 21, 2014).

[73] "The Minerva Initiative," http://minerva.dtic.mil/ (accessed 28 August 2015).

[74] T. Cerry and A. Chaturvedi, "Sentient World Simulation: A Continuously Running Model of the

also funded research in the context of its Social Media in Strategic Communications project, exploring how emotions of users can be manipulated through social media.[75] Ultimately, the various information/software initiatives focus on social and behavioral research for understanding "cultural and political environments…where threats develop."[76] Such research can potentially be used for the political and psychological subversion of other societies or for social engineering, which was a concern for the older and similar Project Camelot.[77]

A further extension of PSYOPS is the use of sophisticated battlefield illusions to directly manipulate enemy perceptions. For example, DARPA has made $4 million dollars available for research into how the brain processes sensory perception information so that perceptions can be managed to "confuse, delay, inhibit, or misdirect [the enemy's] actions."[78] Around the world defense establishments are also working on invisibility cloaks and holograms that can make an object disappear or to create a convincing illusion of a non-existent object. Enemies might be easily manipulated into surrendering if they saw endless columns of holographically projected soldiers marching towards them or divine apparitions (a 'Face-of-Allah' weapon).[79]

Military Information Support Operations already intersect heavily with cyber security and cyber operations because of the possibility of conducting PSYOPS on and via the Internet. Once neural devices are more commonly used as computer input and brain stimulation devices directly connected to computers, they could be hacked just like any other piece of electronics, the difference being that it is not just the normal functioning of an external device that is at stake but the functioning of a user's brain. A hacker of a neural device could alter brain waves, moods, mental state and capacity of the user, and might even take control of a user's body through a BCI to perform an unintended action.[80] Such neural hacking could even permanently 'rewire' the brain of the user or 'brainwash' them.

Less technologically sophisticated methods of 'mind hacking' are imaginable. Malicious software might attack the minds of users by manipulating the flicker rate of the monitor and by displaying subliminal messages on the screen that cannot be consciously perceived.[81] Although the effectiveness of subliminal messages has been often dismissed, neuroscientists have found indications that subliminals do work in the sense of somewhat affecting the behavior of people who have been exposed to them – at least sometimes.[82] It is uncontroversial that the advertising industry has experimented with subliminals as described in Vance Packard's 1957 book *The Hidden Persuaders*.[83] Subliminal advertising has sparked enough concerns to prohibit them in many countries, including the United States. The Russian government has even decided to automatically scan media for subliminal messages after it was reported in 2002 that a Russian TV station included subliminals in their programming

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Real World," W. Lafayette, IN: Purdue University, August 22, 2006.

[75] Ben Quinn and James Ball, "US Military Studied How to Influence Twitter Users in Darpa-funded Research," *The Guardian*, July 18, 2014, http://www.theguardian.com/world/2014/jul/08/darpa-social-networks-research-twitter-influence-studies (accessed December 29, 2014).

[76] "The Minerva Initiative," U.S. Department of Defense, http://minerva.dtic.mil/ (accessed September 8, 2015).

[77] Robert A. Nisbet. "Project Camelot: An Autopsy," *The Public Interest* (Fall 1966): 45-69.

[78] Noah Shachtman, "Darpa's Magic Plan: 'Battlefield Illusions' to Mess with Enemy Minds," *Wired Blog*, February 14, 2012, http://www.wired.com/2012/02/darpa-magic/ (accessed December 29, 2014).

[79] Sharon Weinberger, "The face of Allah Weapon Returns," *Wired.com*, May 13, 2008, http://www.wired.com/2008/05/the-face-of-all/ (accessed September 8, 2015).

[80] Hedley Leggett, "The Next Hacking Frontier: Your Brain?" *Wired.com*, July 9, 2009, http://www.wired.com/2009/07/neurosecurity/ (accessed 4 November 2014).

[81] Thomas, "The Mind Has No Firewall."

[82] Gráinne Fitzsimons, Tanya L. Chartrand and Gavan Fitzsimons, "Automatic Effects of Brand Exposure on Motivated Behavior: How Apple Makes You 'Think Different'," *Journal of Consumer Research* 35: 21-35.

[83] Vance Packard, *The Hidden Persuaders* (New York: D. McKay Co., 1957).

to manipulate their viewers to keep watching it.[84] Research has shown that people can emotionally respond to subliminal cues and that this can affect attitudes and behaviors.[85] The danger in subliminals may not lie in directly causing action, but in their capability of slowly shifting perceptions, attitudes, and beliefs after an extended period of exposure to them.

THE MIND AS A NEW DOMAIN OF WARFARE

There is little doubt that neuro S/T has numerous military and security applications, but does this amount to any revolutionary change or create a new domain of war? Is neurowarfare just an evolution of existing methods of war and technologies, or does it actually introduce a new quality? Some may argue that psychological warfare goes back to Ancient times and was already advocated by military theorist Sun Tzu, who counseled in *The Art of War* that "[t]o subdue the enemy without fighting is the acme of skill."[86] Neurowarfare might be just a refinement of PSYOPS with some marginal improvements in this area. However, modern PSYOPS still remains limited to using *communications* for influencing the "emotions, motives, objective reasoning, and behavior" of a target audience,[87] while neurowarfare promises something different: direct external control of human consciousness through targeted manipulation of the brain. As Robert McCreight has argued, "[t]houghts, beliefs, perceptions, ideas, and behaviors could be made directly vulnerable to external threat and control for the first time in human history."[88] If it can be achieved, states and other actors will aim to dominate 'neurospace', bypassing conventional military capability and other traditional defenses of society, in order to gain a decisive advantage in a conflict.

Neocortical Warfare

RAND analyst Richard Szafranski proposed in 1997 the term 'neocortical warfare' to describe a new paradigm of war. Szafranski criticized the Clausewitzian paradigm for being overly focused on the need for violence as the main instrument of coercion. Szafranski suggests "the intellectual energy consumed by devising newer and better ways to kill and destroy distracts us from the real object of war: subduing hostile will. Lopping the limbs off an enemy's body, or even precisely excising muscles from it, undoubtedly sends a message to the enemy's brain. Might there not be other ways to communicate with hostile brains?"[89] He goes on to further delineate neocortical warfare from the older paradigm:

> 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. In simple ways, neocortical warfare attempts to penetrate adversaries' recurring and simultaneous cycles of 'observation, orientation, decision and action.' In complex ways, it strives to present the adversary's leaders—its collective brain—with perceptions, sensory and cognitive data designed to result in a narrow and controlled (or an overwhelmingly large and disorienting) range of calculations and evaluations. The product of these evaluations and calculations are adversary choices that correspond to our desired choices

[84] Robyn Dixon, "Abusing the Power of Suggestion in Russian Ads," *Los Angeles Times*, August 25, 2002, http://articles.latimes.com/2002/aug/25/world/fg-russtv25 (accessed December 29, 2014).
[85] A. Sharma, "Subliminal Perception: Conceptional Analysis and Its Rampant Usage in Advertisements and Music Industry," *Indian Journal of Health and Wellbeing* 6 (2015): 640-643.
[86] Sun Tzu, *The Art of War*, Chapter 3.
[87] U.S. Army, "Psychological Operations, Tactics, Techniques, and Procedures," FM-3-05.301: 1.2.
[88] McCreight, "Brain Brinkmanship," p. 117.
[89] Richard Szafranski, "Neocortical Warfare: The Acme of Skill," in David Ronfeldt and John Arquilla, *In Athena's Camp: Warfare in the Information Age* (Santa Monica, CA: RAND, 1997), p. 398.

> and the outcomes we desire. Influencing leaders to not fight is paramount.[90]

What Szafranski is calling neocortical warfare is referred herein as neurowarfare: the manipulation of enemy brains for the goal of subduing their will. Similarly, Australian defense analysts Chloe Diggins and Clint Arizmendi have argued that neurowarfare is "about *involuntarily* penetrating, shaping, and coercing the mind in the ultimate realization of Clausewitz's definition of war: compelling an adversary to submit to one's will."[91] This goes clearly beyond PSYOPS and can be aimed at degrading mental capacity, altering mental states, altering emotions, and potentially impacting higher cognitive functions of perception, thinking, memory, and learning (Fig. 1). Neurowarfare is also culturally agnostic in the sense that people can be influenced at a level of the brain, potentially bypassing cultural factors and peculiarities.

The Human Domain

In recent years the U.S. military adopted the concept 'human domain', which is added as a sixth domain of war apart from land, sea, air, outer space, and cyberspace. The human domain comprises 'human factors' and the 'human terrain'. Human factors deal with aspects of human nature and human capability that are difficult to measure but that are critically important in war and its conduct, namely, culture, motivation, morale, emotions, training, leadership, and so on. The 'human terrain' is "the human population in the operational environment ... as defined and characterized by sociocultural, anthropologic and ethnographic data and other non-geographical information."[92] The U.S. Army continues to develop HTS by combining it better with geographic information systems so that everybody and all activities can be tracked and referenced to a geographic location for better situational awareness in the human domain.

A 2012 DoD white paper on 'Strategic Landpower' declared the central importance of the human domain to all warfare and argued "[w]hat we know and project about the future operating environment tells us that the significance of the 'human domain' in future conflict is growing, not diminished."[93] The paper emphasizes the continued importance of landpower and the growing importance of conflicts short of war, where lethal power may not be the most effective way to meet U.S. strategic goals. It clearly hints at possibly covert methods of influencing other societies so that actual warfare becomes unnecessary.

A subsection of the human domain that could emerge in the future could be called 'neurospace': the technical interface at which brains and minds interact with their environment. Chloe Diggins and Clint Arizmendi have argued that neural interfaces such as neural devices and BCIs could become ubiquitous and that they could therefore become targets of cyber attacks:

> "The possibilities for damage, destruction, and chaos are very real. This could include manipulating a soldier's BCI during conflict so that s/he were forced to pull the gun trigger on friendlies, install malicious code in his own secure computer system, call in inaccurate coordinates for an air strike, or divulge state secrets to the enemy seemingly voluntarily."[94]

In light of the rapid advances in neuro S/T it no longer seems far-fetched that militaries will seek to dominate neurospace by hacking the human brain and by devising new technologies that harden own personnel against neurowarfare attacks. In many respects neurowarfare would be fairly similar to cyber warfare with the exception that attacks are not directed against technical systems and networks, but against biological cognitive systems, which may occur through some neuro-cyber interface or BCI and which would aim to steer consciousness. Some researchers have

[90] Ibid.: 404.
[91] Diggins and Arizmendi, "Hacking the Brain."
[92] J. Kipp, L. Grau, K. Prinslow, and D. Smith, "The Human Terrain System: A CORDS for the 21st Century," *Military Review* (September-October 2006): 9.
[93] U.S. DoD, "Strategic Landpower: Winning the Clash of Wills," White Paper, November 2012, p. 5.
[94] Diggins and Arizmendi, "Hacking the Brain."

even suggested the creation of an 'Internet for minds,' thereby creating a 'noosphere' that could one day form a super-intelligent hive mind.[95] Combat in neurospace would become a struggle over the formation and direction of collective consciousness. What follows in the final section is brief discussion of key strategic problems related to neurowarfare.

Approaches to Neurowarfare

In principle, neurowarfare can be waged defensively and offensively. In a defensive function neurowarfare may be used to suppress conflicts before they can break out. A potentially hostile society may be calmed and hostile attitudes or perceptions adjusted accordingly. For example, defense analyst Henrik Friman has pointed out, perceptions of winning and losing are central to all forms of warfare. So if one could somehow manipulate enemy leaders into believing that they have won, they would terminate hostilities before they have actually gained the advantage they originally sought or they may never see the need for resistance in the first place.[96] In an operational environment, where *"[t]he most compelling future defense-relevant shocks are likely to be unconventional,"* the importance of managing perceptions of potentially hostile populations grows.[97]

Occupied populations could be more easily pacified and incipient insurgencies could be more easily suppressed before they gain any traction. Calmatives could be put into the drinking water or populations could be sprayed with oxytocin to make them more trusting. Potential terrorists may be detected using brain scans and then chemically or otherwise neutered.[98] This obviously creates the possibility of creating a system of high-tech repression, where in the words of writer Aldous Huxley "a method of control [could be established] by which a people can be made to enjoy a state of affairs by which any decent standard they ought not to enjoy."[99]

Offensive neurowarfare would be aimed at manipulating the political and social situation in another state. It could alter social values, culture, popular beliefs, and collective behaviors or change political directions, for example, by way of regime change through 'democratizing' other societies – a complaint that is frequently heard from Russia.[100] A Special Operations Command White Paper claims "Russia, China, and Iran currently conduct political warfare activities to further their individual goals" and suggests a "strategy enabling the U.S. to influence local struggles in a positive direction" should be developed.[101] However, offensive neurowarfare could also mean collapsing adversarial states by creating conditions of lawlessness, insurrection, and revolution, for example, by inducing fear, confusion, or anger. Adversarial states could be destabilized using advanced techniques of subversion, sabotage, environmental modification, and 'gray' terrorism, followed by a direct military attack.[102] As a result, the adversarial state would not have the capacity to resist the policies of a covert aggressor. Neurowarfare could take down a

[95] George Dvorsky, "How Much Longer Until Humanity Becomes a Hive-Mind?" *IO9 Magazine*, March 15, 2013, http://io9.com/how-much-longer-until-humanity-becomes-a-hive-mind-453848055 (accessed August 29, 2015).

[96] Henrik Friman, "Perception Warfare," Swedish National Defense College: Stockholm, Discussion Paper.

[97] Nathan Freier, *Known Unknowns: Unconventional 'Strategic Shocks' in Defense Strategy Development* (Carlisle Barracks, PA: US Army War College Strategic Studies Institute, 2008), p. 14.

[98] Sharon Weinberger, "Mind Games," *The Washington Post*, January 14, 2007, http://www.washingtonpost.com/wp-dyn/content/article/2007/01/10/AR2007011001399.html (accessed September 8, 2015).

[99] Aldous Huxley, "Interview with Aldous Huxley," Berkeley Language Center, March 20, 1962, http://www.informationclearinghouse.info/article31319.htm (accessed September 8, 2015).

[100] Andrew Korybko, *Hybrid Wars: The Indirect Approach to Regime Change* (Moscow: Institute for Strategic Studies and Predictions, 2015).

[101] U.S. Special Operations Command, *Counter-Unconventional Warfare*, White Paper, September 26, 2014, p. 12.

[102] S.G. Chekinov and S.A. Bogdanov, "The Nature and Content of a New-Generation War," *Military Thought* 4 (2013): 19-20.

strategic competitor permanently without nuclear war and the risk of devastating nuclear retaliation.

Targeting

Like cyber warfare bypasses the battlefield, neurowarfare bypasses the state altogether and might target individual civilians (political leaders), societal subgroups, or entire societies. As a result, the traditional distinction between combatants and noncombatants may become meaningless. There is already a legal debate over the question whether and under what conditions civilians can be targeted with nonlethal weapons, for example, in the context of counterterrorism and counterinsurgency operations.[103] This debate is bound to intensify once neuroweapons mature.

A further complication with respect to noncombatant targeting arises from the tendency that neuroweapons may be employed covertly without the target of the attack ever being aware of the attack.[104] A neurowarfare attack may not even cause any physical harm to a person subjected to it and may in this respect be akin to targeting civilians with propaganda, however, with more drastic and immediate effects. Enemy leaders could be targeted to degrade their ability to make sound decisions or to steer their decisions into a particular direction. Individuals may be driven insane and manipulated into random acts of violence. Societal subgroups may be manipulated into rising against their government, and whole societies may be thrown into political turmoil and chaos.

While such methods of war seem intuitively objectionable from an ethical point of view, they increasingly represent the current reality of 'hybrid warfare', 'political warfare', and other forms of societal destabilization that are being employed with great effectiveness by several major nations.[105] There is currently no legal protection against mind manipulation, although one can argue that covert mental coercion would violate human dignity and by extension human rights.[106]

Deterrence

How can we deter neurowarfare attacks? Deterrence can be defined as "the use of threats to dissuade an adversary from initiating an undesirable act."[107] Its success depends on two factors: the threat needs to be clearly communicated to the adversary and secondly, the threat needs to be credible. The credibility of the threat again depends on two factors, namely, the capability of the coercer to carry out the threat and the likelihood that the threat will actually be carried out when the undesirable act occurs.

'Neurodeterrence' can have two meanings: 1) deterrence based on insights gained from neuro S/T and 2) deterrence with neuroweapons or against neurowarfare. In the first meaning, neurodeterrence is clearly possible: neuroscience can gain great insights into foreign cultures and how S/T affects brain functions and decision making as pointed out by the NRC study.[108] In this sense, neuroscience can help understand the true motivations of an opponent in order to find a punitive strategy that would most strongly influence an adversary's behavior.[109] Secondly, nations will want to deter the use of neurowarfare against them, or they might use neuroweapons for deterrence more generally as part of their defense posture.

Currently, there are some key problems with deterring a possible neurowarfare attack by an adversarial state. A threat may be communicated in secret using diplomatic channels saying that if neuroweapons are used by the adversarial state it will produce a certain unfavorable response. The

[103] John W. Lango, "Nonlethal Weapons, Noncombatant Immunity, and Combatant Nonimmunity: A Just War Theory," *Philosophia* 38 (2010): 475-497.
[104] McCreight, "Brain Brinkmanship," p. 117.
[105] U.S. Special Operations Command, *Counter-Unconventional Warfare*, p. 3.
[106] J.C. Bublitz and R. Merkel, "Crimes against Minds: On Mental Manipulations, Harms and a Human Right to Mental Self-Determination," *Criminal Law and Philosophy* 8 (2014): 51-77.
[107] L. Freedman and S. Raghavan, "Coercion," in P.D. Williams, *Security Studies: An Introduction* (London: Routledge, 2008), p. 217.
[108] NRC, *Emerging Cognitive Neuroscience and Related Technologies*, p. 9.
[109] Canna, "Leveraging Neuroscientific and Neurotechnological Developments," pp. 3-4.

problem is that unless the public is made aware that an invisible or indirect attack with neuroweapons against a state's leader or population has occurred, it will not support any open punitive action against the aggressor. The response would therefore have to be limited to some covert action, possibly a response in kind, attacking the minds of the adversary's leaders and population, which risks escalation. Furthermore, secret weapons would unlikely deter an aggressor for the simple reason that capabilities have to be demonstrated in order to make a threat credible. Secret military capabilities have little deterrence value.

Unfortunately, there are few incentives for any nation that succeed in developing neuroweapons to openly declare that they have them and might use them. Such a declaration would be counterproductive for several reasons: the declaration might spark a neuroscience arms race as more powers would seek these capabilities, the advantage of surprise would be lost, and other states may find effective countermeasures. Not surprisingly, many states have kept their research into potentially revolutionary nonlethal weapons secret from the public for decades.[110] The result may be that governments adopt by default an opaque posture with respect to their neurowarfare capabilities, which could potentially result in a failure of deterrence and subsequent disaster. Some nations may be able to use a perceived capacity for developing neuroweapons as leverage in international relations, getting concessions from much more powerful states.[111]

Threshold to War

There is a common problem with respect to all nonlethal approaches to warfare, be it cyber warfare, economic warfare, financial warfare, or ideological subversion, and that is the question under what circumstances the threshold to war has been crossed and when a kinetic response to the nonlethal attack could be justified. Neurowarfare directed against enemy leaders, enemy forces, and an enemy's society could be conducted in peacetime or outside a declared armed conflict. Just like cyber warfare, neurowarfare is inherently difficult to define and regulate since both methods of war could be generally conducted covertly, are difficult to attribute, and often cause no visible effect or damage. Up to now cyber war has only been able to produce a limited degree of societal disruption by making targeted web services temporarily unavailable and by causing financial damage.

However, cyber warfare is still seen as being potentially able to bring a nation to its knees through sophisticated attacks against critical infrastructure such as the electricity grid, mass transportation systems, and stock markets. For this reason an emergency conference-call system that includes all key cyber war decision-makers has been set up for the event of a major cyber attack on the nation, including a dedicated emergency communications line from Washington to Moscow.[112] The authority for engaging in offensive cyber operations outside of an armed conflict rests with the President, which again indicates that cyber warfare activities are indeed considered 'war' and not merely an extension of espionage that does not require such authorization.[113] The rationale for these restrictions for offensive cyber operations is based on the risk of unwanted escalation and the risk of unintended large-scale collateral damage, which would also apply to neurowarfare and other methods of subversion.

Currently, arms control agreements do not cover neuroweapons, as the technology could fall in between the CTC and BWC.[114] The use of neuroweapons might be treated similarly to cyber warfare activities and could be correspondingly restricted, both domestically and internationally. A 'no first use' doctrine might make sense with respect to offensive neurowarfare. Governments

[110] Pasternak, "Wonder Weapons."
[111] McCreight, "Brain Brinkmanship," p. 121.
[112] Shane Harris, *@War: The Rise of the Military-Internet Complex* (Boston, MA: Houghlin Mifflin Harcourt, 2014), p. 60.
[113] David E. Sanger and Thom Shanker, "Broad Powers Seen for Obama in Cyberstrikes," *The New York Times*, February 3, 2013, http://www.nytimes.com/2013/02/04/us/broad-powers-seen-for-obama-in-cyberstrikes.html?pagewanted=all&_r=0 (accessed December 12, 2014).
[114] Requart, "This Is Your Brain."

and other organizations also would be well-advised to think about effective 'neuro-defenses' that can protect leaders, personnel, and society at large from sophisticated attacks on their minds, including their perception, emotions, and consciousness. Unfortunately, the great secrecy surrounding neuroweapons can be detrimental, as it could lead to underestimating a very real and growing threat. So one can ask the question, "Should we risk waiting until the tangible first evidence of neuroweapons research has landed on the front page of our major newspapers and CNN [before we start thinking about the threat]?"[115] Governments need to make it clear under what conditions they would use neuroweapons and how a neuroweapons attack by a foreign power would be answered. In short, a neurowarfare doctrine is needed and should be developed before neurowarfare becomes a reality and a tangible threat.

CONCLUSION

Neuroscience research will have a substantial impact on warfare and security in numerous ways, ranging from the enhancement of personnel, the improvement of strategic intelligence, new screening devices that can detect hostile intentions or guilty knowledge, thought-controlled weapons, and offensive neuroweapons that can directly influence mental capability, perception, emotions, and thoughts of people. The sum total of the military applications of neuro S/T can be called neurowarfare, and it may become a distinctive domain of warfare in its own right. 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. Considering the dangers of neuroweapons and the prospect of governments and terrorist groups secretly wielding neuroweapons against individuals, groups, or society in pursuit of strategic goals within a decade or so, it is time to think seriously about how to protect leaders, government personnel, and society at large – and about how neurowarfare can be governed.

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[115] McCreight, "Brain Brinksmanship," p. 125.

Figure 1 (*Source*: Author).

The Spectrum of Neurowarfare			
	Technique	Target	Objectives
Neurowarfare	Manipulation of the brain	Attack on consciousness	• Directly control human behaviour • Insert/ manipulate thoughts, perceptions, dreams • Manipulate emotions
		Attack on mental capacity	• Degrade cognitive functions • Interfere with perception • Alter mental states
	Predictive algorithms, simulations, brain imaging	Brain functions/ consciousness	• Steer society at large • Influence individual or collective behaviour • Predict threats/ developments/ behaviours • Access memory • Deception detection
PSYOPS	Communication (mass media, Internet)	Attack on perception	• Influence behaviour • Influence beliefs • Influence perceptions • Influence emotions