From Psyops to Neurowar: What Are the Dangers?

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ABSTRACT: There is a scientific race for decoding the human brain. Current and near future technology will make it possible to not only merely influence the enemy's mind and behavior, but to actually control it. Breakthroughs in neuroscience will enable new types of non-lethal weapons for precise behavioral manipulation, for example through behavior-altering neurotropic drugs, through remote electromagnetic brain monitoring and stimulation, through acoustic weapons beaming voices directly into enemy heads, and even through holographic projections and other 'complex battlefield illusions.' Within ten years soldiers could be equipped with transcranial magnetic stimulation devices or brain-computer interfaces, which would make it possible for their commanders to steer their emotions and to control their thoughts. This paper will discuss how the emerging sixth domain of warfare (the mind) is likely to transform military operations and profoundly change how wars are conducted. It is argued that military operations will be increasingly centered on achieving desired psychological effects, which will, on the positive side, reduce the need for physical destruction and killing. At the same time, 'neuroweapons' will also create new and unprecedented dangers, resulting from misuse and proliferation, which will need to be addressed through development of a concept of 'neurosecurity' that will be outlined.

KEYWORDS: Emerging Military Technology, Operational Neuroscience, Non-Lethal Weapons, Neurosecurity

Neuroscience is currently one of the fastest growing areas of science in the United States. It is an interdisciplinary field that seeks to connect and integrate "calculus, general biology, genetics, physiology, molecular biology, general chemistry, organic chemistry, biochemistry, physics, behavioral psychology, cognitive psychology, perceptual psychology, philosophy, computer theory, and research design."[1] It is inevitable that neuroscience research will impact on national security in complex ways in the next decades, which has already been the subject of a 2008 Defense Intelligence Agency sponsored study by the National Research Council.[2] Advances in neuroscience might even trigger a neurotechnology arms race, as nations that could leverage neurotechnology better than others could gain a decisive advantage in warfare.[3] This paper argues that new methods of influencing the brain and the central nervous system and thereby mental capacity, emotion, and thought could become central to future military strategy and the conduct of war, conflict, and economic competition. While 'neuroweapons' and 'neurowarfare'

[1] Jonathan Moreno, *Mind Wars: Brain Science and the Military in the 21st Century* (New York: Bellevue Literary Press 2012), 32.
[2] National Research Council, *Emerging Cognitive Neuroscience and Related Technologies* (Washington, DC: National Academies Press 2008).
[3] Moreno, *Mind Wars*, 30.

may still sound like science fiction or something that might only arrive in a very distant future, it is notable that neuroweapons are neither in principle technologically impossible, nor do they necessarily require technologies not yet in existence. They are in essence weapons that target the brain and the central nervous system. Depending on the precise definition of the term neuroweapon one could even argue that some primitive versions of them may already exist, such as the commercially available Myotron, which overloads the central nervous system through direct contact and thereby jams brain signals that control voluntary muscle movements.[4] Various neuropharmalogical drugs that impact on mental capacity and behavior are currently being researched by defense establishments around the world for possible usage in combat scenarios, amongst them modafinil, oxytocin, and propranolol.[5] Monitoring or manipulating the brain and central nervous system remotely can be done with existing technologies such as EEG or fNIRS headsets, radio-frequency waves/ microwaves or pulsed ultrasound precisely targeted at specific areas of the brain. Considering recent investments and advances in neuroscience by many major countries, especially in areas such as brain stimulation and brain-computer interfaces, neuroweapons and neurowarfare could emerge already in the decade of 2015 to 2025.[6] Furthermore, the potential consequences of mapping and decoding the brain could be more grave than any other scientific breakthrough in human history since it could affect the very concept of free will and individual autonomy on which liberal democratic society is based. Addressing the dangers that come with the future development and proliferation of neuroweapons and resulting neurowarfare will require a comprehensive approach towards 'neurosecurity' that can minimize the dangers, which will be outlined below.

The Growth of Military Neuroscience

In February 2013 President Obama announced the BRAIN Initiative that provided additional $100 million dollars annually in neuroscience research funding through the NSF from fiscal year 2014 over the next decade. This comes at a time of overall shrinking federal research funding, which highlights that the Obama administration considers brain research to be a research field of strategic importance. The officially stated goal of the NSF BRAIN Initiative is "to generate an array of physical and conceptual tools needed to determine how healthy brains function over the lifespan of humans and other organisms; and to develop a workforce to create and implement these tools aimed at establishing a more comprehensive understanding of how thoughts, memories and actions emerge from the dynamic activities in the brain."[7] While the initiative aimed at civilian and health applications, there is a growing concern by bioethicists like Jonathan

[4] Douglas Pasternak, 'Wonder Weapons', *U.S. News and World Report* 123/1, 38-44.
[5] James Giordano and Rachel Wurzman, 'Neurotechnologies as Weapons in National Security and Defense – An Overview', *Synesis* 2011, T:59.
[6] Robert McCreight, 'Brain Brinkmanship: 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), 116.
[7] National Science Foundation, "BRAIN: Brain Research Through Advancing Innovative Neurotechnologies", *NSF website*, <http://www.nsf.gov/news/special_reports/brain/initiative/>, accessed 3 October 2014.

Moreno and also neuroscientists that their research could also be used for military applications that at the very least create some new and challenging ethical dilemmas. Some of these have already been discussed in the 2012 Royal Society report 'Brain Waves Module 3: Neuroscience, Conflict and Security'.[8]

The ethical concerns of neuroscientists are also grounded in previous government efforts to research 'mind control' during the Cold War. The CIA MK Ultra projects of 1953 to 1964, which included 149 subprojects in over 80 research institutions in three countries, were conducted alongside the chemical and biological warfare experimentation of the U.S. Army's Special Operations Division. Some of the research aimed at the development of 'truth drugs', psychochemical warfare methods, and even at developing brain implants for remotely controlling the brains of test subjects.[9] However, at least according to information in the public domain, nothing with an operational value has been produced in this period. Since scientific knowledge of the brain has dramatically increased over the last sixty years this could change very soon and make some of the fantastic goals of Project Artichoke/ MK Ultra research actually achievable. An increasing amount of bold claims about new methods of brain stimulation, synthetic telepathy, and indeed 'mind control' can be now found even in mainstream magazines and newspapers such as *The Economist*, *The Washington Post*, and *Discover Magazine*.[10] What once seemed far out or 'conspiracy theory' has moved somewhat closer into the realm of possibility.

As the Royal Society report pointed out, there are two different goals of national security neuroscience research: 'performance enhancement' and 'performance degradation'. The current emphasis of the research seems to be on performance enhancement through the development of psychopharmaceuticals and brain stimulation methods that increase alertness, reduce stress, and enable the warfighter or intelligence analyst to make better judgments. Methods for monitoring the brains of soldiers such as EEGs built into helmets could be used by commanders to understand their mental state or to automatically alert soldiers when they are about to fall asleep, or to flag threats that are registered by their subconscious.[11] On the horizon are brain-computer interfaces (BCI) that will enable new neuroprosthetics and potentially thought-controlled weapons systems.[12] Much less is known about the military's efforts for developing methods that can degrade the mental performance of the enemy. The aforementioned National Research Council report suggests: "[t]he neurotechnology degradation market segment is completely underground with only speculative information available." The report stresses: "This cognitive weapons market does exist…'[13] There are obvious reasons why governments tend to keep this

[8] Royal Society, *Brain Waves Module 3: Neuroscience, Conflict and Security* (London: The Royal Society 2012).
[9] Cheryl Welsh, 'Cold War Nonconsensual Experiments: The Threat of Neuroweapons and the Danger It Will Happen Again', *Essex Human Rights Review* 9/1 (June 2012), 1-32.
[10] Compare e.g.: 'Leaders: The Future of Mind Control', *The Economist* (25 May 2002), 11; Sharon Weinberger, 'Mind Games', *The Washington Post* (14 January 2007), W22; Adam Piore, 'The Army's Bold Plan to Turn Soldiers Into Telepaths', *Discover Magazine* (20 July 2011).
[11] Moreno, *Mind Wars*, 203.
[12] Royal Society, *Brain Waves Module 3*, 20.
[13] National Research Council, *Emerging Cognitive Neuroscience and Related Technologies* (Washington, DC: National Academies Press 2008), 129.

kind of research very secret: any neuroscience research that even remotely sounds like 'mind control' research carries a social stigma: researchers and government agencies do not want to be associated with that label; the research most likely requires ethically controversial human experimentation, which could not pass the muster of ethics reviews; and finally the effectiveness of some approaches might be substantially reduced if adversaries had knowledge of them and thus could employ effective countermeasures. At the same time, it will not be possible to keep neuroweapons completely secret and out of the reach of adversaries for very long. So it would be better for national security to have a more open discussion about it.

The Enhancement Technologies

Weapons developers see the warfighter increasingly as the weakest link in the 'kill chain': humans have fragile physical bodies and minds, they need water, food, and sleep in regular intervals, and up to now very little could be done to overcome these human limitations. Three approaches seem to be particularly promising in terms of neuroscientific human enhancement: neuropharmacology, brain stimulation, and brain-computer interfaces.

Neuropharmacology

Neuroscientists have gained over the decades an excellent understanding of brain chemistry, which has already led to the development of many new psychotropic drugs such as Prozac. Researchers hope to not only cure depression and other mental disorders, but to ultimately enhance mental capabilities through so-called nootropic drugs. 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.[14] One particular promising 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. Other drugs could reduce stress or anxiety and make it thereby less likely that soldiers will suffer from PTSD at some later point. Roger Pitman from Harvard University uses the beta-blocker propranolol for suppressing if not deleting painful memories of veterans.[15] It could be potentially administered to soldiers before they go into action to prevent the later occurrence of PTSD altogether, which could potentially lead to less behavioral constraints or more aggressive behavior in battle.

[14] Ibid., 5.
[15] Moreno, *Mind Wars*, 152.

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Brain Stimulation

Psychiatrists have used the electrical stimulation of the brain for treating mental illnesses since the late 19th century. The electroconvulsive therapy, in which an electrical current is applied to the brain through electrodes, has been widely used since the 1940s and 1950s and the American Psychiatric Association considers it safe and effective for treating major depression, schizophrenia, and bipolar disorders.[16] Since the early 1980s psychiatrists have developed newer methods for the electrical stimulation of the brain. For example, the Transcranial Magnetic Stimulation (TMS) method that 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 concerns of the safety of the treatment.[17] More recently neuroscience researchers have used TMS for stimulating the motor cortex, which allows one person in a brain-to-brain interface to remotely control the hand movements of another person. This experiment was successfully carried out at the University of Washington in 2013, which could be a first step towards a brain-computer interface (BCI) and synthetic telepathy.[18] The downside of TMS is that it requires a large coil and power source, which are difficult to miniaturize and fit into a smaller headset or helmet. TMS can also not reach deeper areas of the brain. Other currently researched brain stimulation methods are transcranial Direct Current Stimulation (tDCS) and Transcranial Pulsed Ultrasound Stimulation, which may be suitable for integration into a soldier's combat helmet. tDCS applies a weak current through electrodes to the scalp, which has shown to significantly increase concentration and cognitive capabilities in test subjects.[19] Researchers from Arizona State University are working on a Transcranial Pulsed Ultrasound device that can be fitted into a helmet and that could be used for controlling the mental states of soldiers, boosting alertness, and relieving pain from injuries.[20] 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 therefore spread quickly. In fact, there is already a low-cost tDCS (called Focus), which is marketed as a 'gaming device' to improve the concentration of computer gamers.

[16] Robert H. Blank, *Intervention in the Brain: Politics, Policy, and Ethics* (Cambridge, MA: MIT Press), 27.
[17] Ibid., 30.
[18] Doree Armstrong and Michelle Ma, 'Researcher Control Colleague's Motions in 1st Brain-to-Brain Interface', *UW Today* (27 August 2013), http://www.washington.edu/news/2013/08/27/researcher-controls-colleagues-motions-in-1st-human-brain-to-brain-interface/, accessed 6 November 2014.
[19] 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), 172.
[20] Clay Dillow, 'DARPA Wants to Install Ultrasound Mind Control Devices in Soldiers' Helmets', *Popular Science* (9 September 2010), <http://www.popsci.com/technology/article/2010-09/darpa-wants-mind-control-keep-soldiers-sharp-smart-and-safe>, accessed 6 November 2014.

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, as well as transmit information from the brain to a computer. Primitive BCIs already exist. They use electroencephalography (EEG) attached to a computer for reading and interpreting brain activity. EEGs are relatively cheap devices that simply measure the electrical activity on the scalp. It is already possible to use EEGs as simple computer input devices, for example users can move a cursor by simply imagining the movement beforehand.[21] A much more ambitious goal is to measure and catalogue EEG responses to specific words and thus create a machine that could literally read minds. Such research is indeed undertaken by scientists at the University of California, Irvine.[22] Although the Royal Society report claims that "[t]here are very limited prospects for a universal thought reading machine", it does raise concerns about the prospect of new weapons systems with direct neurological control.[23] 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 response times.[24] In particular, DARPA is developing the 'Cognitive Technology Threat Warning System' (CT2WS) that 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 able to better control complex machinery such as robotic exoskeletons or unmanned systems of any kind. The use of neural interface that directly connect a soldier's brain to a weapon could result in greater accuracy and much faster response times. As a result, BCIs will make it possible to have human operated weapons that can remain competitive with respect to fully autonomous weapons systems that are also under development. Using a BCI, soldiers may also be able to silently and efficiently communicate with each other just by thinking.

The Degradation Technologies

Neurotechnologies could be used for degrading the performance of the enemy in various ways, which would enable friendly forces to defeat or neutralize an enemy without using direct violence. Neuroscience could improve existing weapons and methods of nonlethal warfare, e.g. PSYOPS and information warfare (including cyber war). It could also lead to the development of

[21] Jeremiah D. Wander e.a., 'Distributed Cortical Adaptation During Learning of a Brain-Computer Interface Task', *Proceedings of the National Academy of Sciences* 110/26 (2013), 10818-10823.
[22] Eric Bland, 'Army Developing "Synthetic Telepathy", *NBC News* (13 October 2008), <http://www.nbcnews.com/id/27162401/ns/technology_and_science-science/t/army-developing-synthetic-telepathy/#.VEF0x2es_8U>, accessed 6 November 2014.
[23] Royal Society, *Brain Waves Module 3*, 16, 20.
[24] 'Weapons of Perception: Neuroscience and Mind-Controlled Weapons', *Army-Technology.com* (22 May 2012), <http://www.army-technology.com/features/featureweapons-of-perception-neuroscience-mind-controlled-weapons-and-the-military/>.

entirely new nonlethal weapons, which could be called 'neuroweapons'. 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."[25] This could be achieved through a variety of means: biochemical agents, directed energy weapons, and even information/ software.

Biochemical Neuroweapons

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. A frequently cited case is the use of the chemical fentanyl by the FSB during the Moscow theatre siege in October 2002. The chemicals were intended to put the Chechen terrorists to sleep, which also killed 128 hostages (out of over eight hundred) because of a delayed and wrong medical emergency response.[26] What is particularly interesting is that the use of fentanyl was not internationally condemned as a violation of the Chemical Weapons Convention, which suggests that governments consider the use of biochemical incapacitants as legal. There could be a range of new neuropharmaceuticals under development that could produce relatively predictable behavioral effects. 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 occurrence of resistance. 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.[27] Even a 'zombie bomb' is imaginable: the alkaloid drug scopolamine is known for putting people exposed to it in a highly suggestible state, in which they lose their free will.[28] Jonathan Moreno seems to be also concerned about future 'brain targeted bioweapons' that could alter behavior. 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.[29] Since human behavior is at least partially influenced by their genetics, nonlethal behavior modifying genetic bioweapons could thus be, in principle, possible.

[25] Ibid.
[26] David A. Koplow, *Non-lethal Weapons: The Law and Policies of Revolutionary Technologies for the Military and Law Enforcement* (Cambridge: Cambridge University Press 2006), 100-112.
[27] 'US Military Pondered Love Not War', *BBC News Online* (15 January 2005), <http://news.bbc.co.uk/2/hi/4174519.stm>.
[28] Jose de Cordoba, 'In Colombia, the Drug Burundanga Is Street Thugs' Weapon of Choice', *Wall Street Journal* (7 July 1995), 1.
[29] Carl Zimmer, 'Parasites Practicing Mind Control', *The New York Times* (28 August 2014), <http://www.nytimes.com/2014/08/28/science/parasites-practicing-mind-control.html>.

Directed Energy Weapons (DEW)

This is 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 sound or acoustic weapons. What is special about DEW is that their weapons effects are generally scalable from lethal to nonlethal. Although much of DEW research is secret, especially when it comes to antipersonnel DEW, there are a couple of weapons systems that have been presented to the public and that are operational. For example, there 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.[30] Similar is the Long Range Acoustic Device, which uses directed loud sound that is painful over a hundred meters.[31] Then there are antipersonnel DEW that 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.[32] Jonathan Moreno also claims: "Electromagnetic waves may be used to disrupt an enemy soldier's nervous system, to cause epileptic seizures, or to warm their body fluids as though they were inside a microwave oven."[33] In the 1980s animal experiments with directed energy weapons have shown promise in terms of affecting mental states and behavior.[34] A voice-of-good weapon that projects voices directly into the heads of individuals in support of PSYOPS could be possible.[35] It is also 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.[36] 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."[37] In the future it might be possible to influence moods and mental capacity using the electromagnetic spectrum, thus induce passive, peaceful, riotous, or any other desirable behavior.

[30] Moreno, *Mind Wars*, 176.
[31] Juliette Volcler, *Extremely Loud: Sound as a Weapon* (New York: The New Press 2013), 109-111.
[32] U.S. Army, 'Bioeffects of Selected Nonlethal Weapons'.
[33] Jonathan Moreno, *Undue Risk: Secret State Experiments on Humans* (New York: W.H. Freeman & Co. 2000), 289.
[34] Pasternak, 'Wonder Weapons'.
[35] Sharon Weinberger, 'The Voice-of-God Weapon Returns', *Wired Blog* (21 December 2007), <http://www.wired.com/2007/12/the-voice-of-go/>, accessed 6 November 2014.
[36] Timothy Thomas, 'The Mind Has No Firewall', *Parameters* (Spring 1998), 84-92.
[37] James F. Dunnigan, *Digital Soldiers: The Evolution of High-Tech Weaponry and Tomorrow's Brave New Battlefield* (New York: St. Martin's Press 1996), 223.

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 it 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."[38] The context to national security is to understand why certain narratives are believed and others not and how narratives can support terrorism. The used 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. Such research can be used to make propaganda or psychological operations more effective or to undermine the propaganda of an adversary. Military Information Support Operations already intersect with cyber security and cyber operations because of the existence of online communities and social networks through which information spreads and through which people can be influenced. Once neural devices are more commonly used and are connected to computers they could be hacked like any other piece of electronics, the difference being that it is not just the correct functioning of an external device that is at stake, but also the functioning of the minds of users. A hacker of 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.[39] Such hacking of a neural device and thus a user 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.[40] 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.[41]

Threats and Challenges

The term 'neurowarfare' has been in use for several years to broadly describe the military utilization of neuroscience and technology (neuro S/T).[42] From the current literature three different aspects of 'neurowarfare' can be distinguished: 1) neurowarfare as neuro enhancement

[38] DARPA, 'Narrative Networks', Biological Technologies Office/ DARPA website, <http://www.darpa.mil/Our_Work/BTO/Programs/Narrative_Networks.aspx>, accessed 21 October 2014.
[39] Hedley Leggett, 'The Next Hacking Frontier: Your Brain?', Wired Blog (9 July 2009), <http://www.wired.com/2009/07/neurosecurity/>, accessed 4 November 2014.
[40] Timothy Thomas, 'The Mind Has No Firewall', *Parameters* (Spring 1998), 84-92.
[41] 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* 35/1, 21-35.
[42] Compare Zach Lynch and Byron Laursen, *The Neuro Revolution: How Brain Science Is Changing Our World* (New York: St. Martin's Press 2009), 153-180.

of own personnel that allows them to perform better in terms of their cognitive abilities and decision-making; 2) neurowarfare as getting inside the heads of enemies for interrogation and strategic intelligence using neuro S/T; and 3) neurowarfare as neuro S/T enabled methods for influencing enemy behavior much more directly than mere PSYOPS. The ongoing academic debate on the potential future role of neuro S/T has already led some commentators to suggest that brains are becoming the new battlegrounds.[43] The mind or 'neurospace' could soon emerge as a new distinct and most likely final domain of warfare after land, sea, air, outer space, and cyberspace.[44]

The most basic idea behind attacking the minds of enemies is very old. It has been first formulated by Sun Tzu, who pointed out that "[t]o subdue the enemy without fighting is the acme of skill." Similarly wrote PSYOPS specialists Paul E. Valley and Michael Aquino "that wars are fought and won or lost not on battlefields but in the minds of men."[45] All warfare is ultimately aimed at forcing the own will on the enemy and manipulating the enemy into accepting defeat and terminating hostilities. In the words of Richard Szafranski "[t]he 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 to choose."[46] So it makes sense to direct most efforts and resources towards the psychological manipulation of the enemy instead of towards the physical destruction of things and the killing of people, which are really secondary to the subjugation of the enemy's will.

If this goal could be accomplished through the technical manipulation of an enemy's brain, which is responsible for our perceptions, emotions, and thinking, no violence would be necessary at all. Any power that could master 'mind control' technology would have achieved a far greater advantage than simply having a nuclear bomb while others have not. At the same time, the use of neuroweapons against entire societies would be much more acceptable than the use of nuclear weapons. As a result, nations will be interested in developing not only neuroweapons, but maybe also dedicated neurowarfare forces and doctrine. It is still hard to imagine how 'cognitive forces' could look like and how they could engage each other in a hypothetical 'neurospace', "where there is only virtuality, digital worlds, or pure consciousness, yet the manifestations and artifices of such combat occur in the realm of the material."[47] However, there are obvious threats and challenges that are either on the horizon or are already a major concern.

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[43] Laura Sanders, 'Brains May Be War's Battlegrounds', *Science News* (17 December 2011), 14.
[44] Chloe Diggins and Clint Arizmendi, 'Hacking the Human Brain: The Next Domain of Warfare', *Wired Blog* (11 December 2012), <http://www.wired.com/2012/12/the-next-warfare-domain-is-your-brain/>.
[45] Paul E. Valley and Michael Aquino, 'From PSYOP to MindWar: The Psychology of Victory', Headquarters 7th Psychological Operations Group, Presidio at San Francisco, CA, 6.
[46] Richard Szafranski, 'Neocortical Warfare: The Acme of Skill', in: David Ronfeldt & John Arquilla, *In Athena's Camp: Warfare in the Information Age* (Santa Monica, CA: RAND 1997), 397.
[47] James Canton, 'Foreword: Toward Our Neurofuture: Challenges, Risks, and Opportunities', in: James Giordano, *Neurotechnology: Premises, Potentials, and Problems* (Boca Raton, FL: CRC Press 2012), XV.

Misuse

All technology can be used for good and bad. While neuro S/T that enhances warfighters, allows us to understand enemies better and to incapacitate them without need for violence might be considered as part of a humanitarian progress in warfare, the very same technology also allows for dangerous scenarios if it was misused. There are also troubling questions about the non-military use of neuroweapons, for example in a domestic national security or law enforcement context. One of the more troubling questions is the use of neuro S/T for the forced treatment of the mentally ill, the criminal, and maybe other social deviants. This idea is old. The psychiatrist Robert Schwitzgebel proposed back in the 1960s a machine that could continuously locate criminals and that could potentially alter their mental states.[48] Terrorists might be electronically neutered so that they can be released into society, which would be cheaper than indefinite detainment, but also creates a host of ethical and legal issues.[49] A major concern is that innocent civilians might be abused for testing new neuroweapons on them.[50] Although Jonathan Moreno does not believe that such illegal experimentation could be currently occurring in the United States, he has acknowledged that some human experimentation will be necessary to develop future neuroweapons: "Because a new generation of weapons is being developed that are intended to incapacitate rather than kill an enemy, computer simulations and animal models can only go so far."[51] So how would one go about on testing the weapons without violating human rights? A problem with the CIA LSD experiments was to test the drug on people when they did not know they were having it. Similarly, it would be important to know how people respond to neuroweapons not knowing they are attacked. Some of the neuroweapons could also result in permanently damaging the health of test subjects. The legal and practical obstacles with respect to conducting human experiments in the West are considerable in the West, which have led some to suggest that this might just happen in great secrecy. But regardless of what the U.S. government does in this arena, it is obvious that there are many countries and even nonstate actors that may have far less qualms about human experimentation and who might attempt to this way gain an advantage over democratic states.

Proliferation

Unfortunately, the broad proliferation of neuro S/T to a wide range of state and nonstate actors is a very likely scenario, as much neuro S/T is inherently dual-use and mostly developed for medical purposes. It would be difficult to deny countries advanced brain scanning and other neurotechnologies on the grounds of national security. Much of the technology could be in reach for nonstate actors and even private individuals. Neural devices, such as BCIs and neural

[48] Gordon Thomas, *Journey Into Madness: The True Story of Secret CIA Mind Control and Medical Abuse* (New York: Bantam Books 1990), 278.
[49] Weinberger, 'Mind Games'.
[50] Welsh, 'Cold War Nonconsensual Experiments'.
[51] Moreno, *Undue Risk*, 289.

implants and prostheses could become very widespread across society within a decade or less. Even some primitive DEW that target the brain or central nervous system do not in principle require resources that are beyond skilled individuals with moderate financial means.

Currently there are few indications of an ongoing global neuro S/T arms race. However, several nations outside the West have recently made substantial investments in medical neuroscience research, namely Japan, India, Iran, and China. The 2008 National Research Council report also cautions there could be a rapid expansion and escalation in the neuroscience degradation market if an effective cognitive weapon was developed by one nation.[52] The fear of falling behind in a crucial military technology area could make a neuro S/T arms race a self-fulfilling prophecy. Jonathan Moreno believes: 'The powers that can claim the advantage and establish a "neurotechnology gap" between themselves and their adversaries will establish both tactical and strategic advantages that can render them dominant in the twenty-first century.'[53]

Up to now the United States still has a clear lead in neuro S/T, but it is foreseeable that others could catch up. The current global neuro S/T market has been estimated to be $150 billion annually with more rapid growth expected in Asia and Latin America, which could overtake the U.S. by 2020. James Giordano argues: "In this light, failing to initiate and maintain neuroS/T RDTE is not acceptable because the USG will lose scientific, as well as economic and arguably military, advantage upon the 21st century world-stage."[54]

It is well established that both Russia and China have researched unorthodox types of weapons that attack the human mind and nervous system in the past. A recent study by Serge Kernbach from the Research Center for Advanced Robotics and Environmental Science in Stuttgart, Germany shows that the Soviet Union had invested over one billion dollars in psychic research and the development of so-called 'psychotronic weapons'.[55] It has been reported in the press that Russia's Ministry of Defense is funding the development of new types of electromagnetic antipersonnel weapons that could 'zombie people' or rather alter mental states and thereby degrade their ability to think and act straight.[56] Zach Lynch mentions in his book several Cold War era Russian research projects for the development of biochemical neuroweapons, such as Project Flute, which would be a neurotoxin that remains dormant until triggered by stress and then could "damage the nervous system, alter moods, trigger psychological changes, and even kill."[57] Military analyst Timothy Thomas has written more than

[52] National Research Council, *Emerging Cognitive Neuroscience and Related Technologies*, 133.
[53] Moreno, *Mind Wars*, 30.
[54] Sarah Canna, 'Leveraging Neuroscientific and Neurotechnological Developments with a Focus on Influence and Deterrence in a Networked World', Carnegie Endowment Neurodeterrence Workshop (18 October 2013), <http://carnegieendowment.org/files/U_NeuroDeterrence_Workshop_Approved_for_Public_Release_31Jan14v2.pdf>, accessed 6 November 2014.
[55] Serge Kernbach, 'Unconventional Research in USSR and Russia: Short Overview', Cybertronics Research, Research Center for Advanced Robotics and Environmental Science, Stuttgart.
[56] Christopher Leake and Will Stewart, 'Putin Targets Foes with "Zombie Gun" Which Attack Victims' Central Nervous System', *Daily Mail Online* (31 March 2012), <http://www.dailymail.co.uk/news/article-2123415/Putin-targets-foes-zombie-gun-attack-victims-central-nervous-system.html>, accessed 6 November 2014.
[57] Zach Lynch, *The Neuro Revolution: How Brain Science is Changing Our World* (New York: St. Martin's Press 2009), 158.

a decade ago about the Chinese being interested in 'new concept weapons' for 'human network attacks', which include 'infrasound weapons, lasers, microwave and particle beam weapons and incoherent light sources.'[58] Given China's growing economic prowess and its investments in neuroscience research, which already alarmed the NRC back in 2008, and its ability to conduct human experimentation on a sufficient scale necessary for developing neuroweapons, the country could leap far ahead of the West. Apart from the conventional military threat by state actors there could be also new security challenges on the horizon.

New Security Threats

Neuro S/T will lead to the emergence of some entirely new and nontraditional security threats, amongst them new challenges to state secrecy and new forms of terrorism. Adversaries might try to remotely monitor the mental processes of leaders or other people of interest. Developing computer models of their minds could enable adversaries to predict their behavior and decisions. Captured personnel could be forced to reveal secrets by scanning their brains or by hacking their brain implants. Since all electronic devices can be in be in principle be hacked, there is no reason to believe that neural devices would be any different. A hacker could remotely hack into brain implants and thereby possibly access and alter the mental states, emotions, thoughts, and memories of people. Unless extensive precautions are taken nobody could be save from having their mental processes monitored and potentially being remotely influenced.

In the 1950s the CIA tried to create 'Manchurian candidates', who could be programmed to carry out any mission without their knowledge or consent, in its Project Artichoke. The CIA tried drugs, hypnosis, electroshocks, and sensory deprivation, also in combination, but was ostensibly unsuccessful.[59] More advanced methods of behavioral modification could make the programmable and unwitting assassin a reality. Long before the CIA became interested in mind control religious cults and radical political groups have used brainwashing techniques for radicalizing and manipulating their members. There are already indications that terrorist groups are brainwashing and indoctrinating children, who are then used for suicide bombings in Afghanistan and elsewhere. Some jihadis are self-radicalized using the Internet as a remote brainwashing tool. The psychiatrist Peter Olssen suggests that "[m]any repeated watching of jihadist websites for hour after hour can be similar to self-hypnosis with posthypnotic suggestion towards violent action."[60] While the brainwashing techniques used by radical religious and political groups are known to be working, but are time-consuming and expensive, terrorist groups and cults might be looking for a short-cut that can more quickly and effectively turn ordinary people into terrorist willing to give up their lives for the cause or to allow themselves to be enslaved. Neuro S/T could provide potentially provide them with such tools. This could make

[58] Timothy Thomas, 'Human Network Attacks', *Military Review* (September/ October 1999), 28.
[59] Compare John Marks, *The Search for the 'Manchurian Candidate': The CIA and Mind Control: The Secret History of the Behavioral Sciences* (New York: W.W. Norton & Co. 1991).
[60] Peter Olsson, *Making of a Homegrown Terrorist: Brainwashing Rebels in Search of a Cause* (Westport, CT: ABC-CLIO 2014), 6.

it extremely difficult to identify terrorists or assassins beforehand since anybody could be turned unwittingly and unknowingly. Terrorist acts that have been programmed into unwitting individuals might be incorrectly described as 'lone wolf' terrorism, which means that connections to the real perpetrators are potentially missed and the nature of the threat remains misunderstood.

These kinds of manipulations would certainly require the kind of technology that only states could have the resources to develop. However, there are also much more primitive neuroweapons that could be easily in reach for even amateur terrorists. There are growing concerns about DIY high energy radio frequency weapons built from modified microwave ovens that could be used for covertly attacking neighbors by exposing them to unhealthy electromagnetic radiation.[61] More and more cases of 'electronic harassment' like James Walbert make it to court and indicate this is already an issue for society to which legislation, courts, and law enforcement needs to respond to.[62]

Neurosecurity

The coming age of neuro warfare necessitates the development of a new concept of security or a new overall strategy for dealing with some of the threats and challenges that come with greater knowledge of the brain and neuro S/T. Jonathan Moreno has proposed the term 'neurosecurity' in his 2006 book, which refers to "both to the ways that science and technology targeted at the brain and nervous system should be managed for the public good, and the means that democratic states must develop to protect themselves from their adversaries."[63] This final section aims to develop further some of Moreno's ideas for neurosecurity, to evaluate the defensive options, and to sketch measures that can be taken for the benefit of national security and the security of society and individuals.

Neurosecurity and Neuroethics

According to Moreno, neurosecurity should be guided by neuroethics, which would have to achieve a balance between the demands of national security and individual liberties to deal with the new threats to public safety and security. He acknowledges that the great secrecy surrounding the development of neuroweapons is a challenge for maintaining democratic accountability.[64] Society will not be able to have a meaningful discussion about neuroethics if the relevant technologies and their true capabilities remain secret. Moreno discusses in this context the secret Soviet bioweapons program, which had been hidden in a civilian research organization named *Biopreparat*. There is the concern that a similarly large neuroweapons program could be

[61] Compare David Gunn, *Poor Man's Ray Gun* (Desert Publications 1996).
[62] David Hambling, 'Court to Defendant: Stop Blasting that Man's Mind!', *Wired Blog* (1 July 2009), <http://www.wired.com/2009/07/court-to-defendant-stop-blasting-that-mans-mind/>, accessed 6 November 2014.
[63] Moreno, *Mind Wars*, 185.
[64] Ibid., 187.

concealed under the guise of biomedical research, which could result in severe breaches of ethical standards, for example with respect to involuntary human experimentation.

In addition, there is the problem that neuroethics, which is a subfield of bioethics, is a relatively young area of philosophic inquiry. It grew out of the ethical concerns of several neuroscientists with respect to the societal impact and uses of their work, who founded the (International) Neuroethics Society in 2006. Up to now there is no overall consensus with respect to many key ethical issues, such as interventions in the brain or the monitoring of mental processes. Tampering with the human mind raises some very fascinating, as well as very troubling ethical questions that any advanced democratic society will have to confront relatively soon. James Giordano and Rachel Wurzman have pointed out "neurotechnology can be used to create weapons that may have unprecedented capacity to alter cognitions, emotions, beliefs, and behaviors of individuals, and groups – if not societies."[65] Some of the questions are: Should soldiers be forced to take drugs that cognitively enhance them or accept invasive or noninvasive neural devices that monitor their brains and that could exercise some level of control over their mental states? Under what circumstances can it be permissible to invade the privacy of other people's minds? When would it be permissible to use mind-altering nonlethal neuroweapons? Should it be allowed to target civilians with such weapons in an effort to win their hearts and minds in counterinsurgencies? Is it permissible to drive enemy combatants into despair and suicide? Should it be permissible to direct neuroweapons against entire societies to promote desirable behavior or for engineering society to cope with challenging problems like environmental degradation or terrorism?

Many of these questions need to be carefully discussed by neuroscientists and ethicists in order to develop an effective legal framework that restrains governments and corporations from using neuro S/T in an unethical manner. There are already a range of legal issues and concerns that come with the use of neuroweapons, which have been raised by the Royal Society report. Some neuroweapons could already violate existing international law, for example biochemical neuroweapons may violate the Chemical Weapons Convention or the Biological and Toxin Weapons Convention.[66] Stephen White has also questioned the legality of brain-machine interface weapons because they could undermine existing international law and legal standards. For example, it could be impossible for a prosecutor investigating war crimes to prove that a soldier whose brain controlled a weapons systems with a BCI has 'willfully' killed non-combatants and would be guilty of a war crime since Western legal standards have always distinguished between thought and action.[67]

Before any neuroweapons are introduced and transitioned to the battlefield the legal and ethical concerns have to be addressed, including concerns about their potential use in a domestic and law enforcement context, as well as the question of forced enhancement and treatment.

[65] James Giordanao & Rachel Wurzman, 'Neurotechnologies as Weapons in National Intelligence and Defense – An Overview', *Synesis* (2011), T:68-T:69.
[66] Royal Society, *Brain Waves*, 8.
[67] Stephen White, 'Brave New World: Neurowarfare and the Limits of International Humanitarian Law', *Cornell International Law Journal* 41 (2008), 194-196.

However, more difficult than the regulation of the use of neuroweapons by governments is the second aspect of neurosecurity, which is 'neurodefense'.

Neurosecurity and Neurodefense

Considering the problem of dual-use applications and the fact that many neurotechnologies could be in reach for many actors, it is inevitable that proliferation will occur and that adversarial and nefarious actors will be tempted to use the new powerful technology. It cannot be expected that all relevant actors will play by the rules, even if it was possible for all governments of the world to agree on a legal framework for the use of neurotechnology in a national security context. This means that steps have to be taken to actively defend against future attacks by adversaries with neuroweapons, maybe even before any are developed or deployed. Neurowarfare attacks could be directed against individuals, groups, or society as a whole. A wide range of different technologies could be employed by a range of actors against a variety of targets with different aims. It follows that defenses need to be multi-layered and multi-faceted. There are four general security strategies that can be considered in the context of developing a doctrine of neurodefense: detection, deterrence, reaction, and adaptation.[68] This section will briefly discuss each one of them.

Detection: successful neurosecurity requires the ability to accurately detect attacks so that one can respond. This would mean the development of a new discipline of 'neuroforensics'. At the moment it is unclear how neuroforensics could look like, but it would have to comprise of a great variety of disciplines and technologies, including cyber security, brain monitoring and scanning, and the detection of antipersonnel DEW and biochemical agents. If attacks are directed against a single individual it could be particularly be particularly difficult, if not impossible, for the individual to understand that they may be influenced or mind controlled. For example, members of religious cults always reject the notion that they may have been brainwashed. The brain simply has no mechanism to detect covert mind manipulation. In the past psychiatrists, who have studied brainwashing techniques, have advised governments and courts about whether individuals have been brainwashed or not as in the famous Patty Hearst case. In the future brain scanning methods might enable neuroscientists to exactly determine whether a brain has been manipulated or otherwise interfered with.

Deterrence: if it was impossible to prevent proliferation of neuroweapons, it could still be possible to deter their use by certain actors. Similarly to cyber warfare it could be difficult to detect attacks and to trace them back to their true origin. Adversaries could be able to successfully conceal their neurowarfare capabilities, carry out attacks covertly, or make it seem that other parties are responsible. Therefore quick and accurate detection capabilities will be key

[68] Fred Cohen, 'Influence Operations', *Fred Cohen & Associates* (2011), <http://all.net/journal/deception/CyberWar-InfluenceOperations.pdf>, accessed 6 November 2014.

to successful deterrence. It could be more difficult to deter nonstate actors, as attacks directed against individuals rather than groups or societies might go undetected for a long time, as they would not produce an effect that is immediately visible. Deterrence would also require some neurowarfare doctrine that spells out what kind of retaliatory action would follow an attack. What kind of threat of a retaliatory action can be plausible for successful deterrence? For example, under what kind of circumstances should a nuclear counterattack be considered?

Reaction: if an attack cannot be deterred, one has to consider how to react to the attack when it does occur. One could respond by destroying whatever weapons systems is conducting the attack or by targeting the enemy's command center controlling the attack. An intuitive solution would be also a response in kind: the response would mirror the attack in type and damage caused. A neuroweapons attack on a society, e.g. a 'neuro-subversion' or attempt to steer the emotions/ mental states of a society, would be answered with a similar type of attack on the enemy's society. This obviously raises the more fundamental question whether such action directed against mostly innocent people would be an ethically appropriate response. Another possibility would be to choose an asymmetric strategy for responding to the attack, aimed at attacking whichever is most valuable to adversary.

Adaptation: in the long run militaries and societies will have to adapt to the threat of neuroweapons by taking extensive protective measures that reduce the enemy's ability to use them effectively. Again, considering the wide range of technologies that could be used for neuroweapons, defensive strategies must be multi-faceted. Timothy Thomas famously pointed out that 'the mind has no firewall'. However, it would have to be a necessary to engineer something like a firewall for the human mind. For example, neural devices need to be designed from the beginning with security in mind.[69] Relevant technology needs to be domestically and internationally controlled. Security services, law enforcement, and courts need to be sufficiently informed about the existence of potential neuroweapons technologies and need to be trained to investigate possible nefarious usage of such technology. The minds of soldiers and of political leaders might need to be shielded against attempts of remote influencing and remote mind control. More ambitiously, societies might even try to shape the neuroecology in a way that reduces opportunities for nefarious manipulation. These will be great challenges, but they are not insurmountable.

Conclusion

Neuro S/T is on the verge of transforming warfare in very fundamental ways. Nations might attempt to conquer the neurospace (a hypothetical space where consciousness connects with the real world), which would be the ultimate domain of warfare from where all other domains (land,

[69] Tamara Denning, Yoki Matsuoka and Tadayoshi Kohno, 'Neurosecurity: Security and Privacy for Neural Devices', *Neurosurg Focus* 27 (July 2009), 2.

sea, air, space, cyberspace) could be theoretically dominated. Considering the enormous breakthroughs in neuroscience, neurowarfare is not a half century away as Moreno suggests, but could arrive a lot sooner. Without doubt our increasing understanding of the brain will lead to many unprecedented challenges and dangers. Neuroweapons will spread, they will be misused, and they will lead to new security threats. But it is important to keep in mind that while neuroweapons that could influence or even control the behavior of enemies may appear for now to be the perfect or ultimate weapons, it will also be possible to defend against them. Most likely, many ideas for successful neurosecurity and defense can be learned from both biosecurity and cyber security. It will be possible to master these challenges. However, more important than neurodefense will be for society and decision-makers to figure out how to use neuro S/T for the betterment of humanity rather than for the perpetuation of human conflict and warfare while not at the same time crushing individual freedom and autonomy. We have to think carefully about neuroethics before rushing into an age of unrestrained neurowarfare.

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