

AIR WAR COLLEGE

AIR UNIVERSITY

WHY FIGHT THE ENEMY THAT YOU CAN REPROGRAM?

by

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Contents

DISCLAIMER i

Biography..... ii

Contentsiii

Introduction..... 1

Section 1: The economic and moral case to fix the brain 2

Section 2: A good map will get you there..... 4

Section 3: A penny for your thoughts 7

 Technology today:..... 7

 Technology Patterns in 2035: 9

 Threats: 10

Section 4: Winning Hearts and Minds 11

 Technology today:..... 12

 Technology Patterns in 2035: 13

 Threats: 14

Section 5: Conclusion 15

Appendix 1: Going back to school..... 17

 Technology today:..... 17

 Technology Patterns in 2035: 19

 Threats: 20

Bibliography 21

Additional Information Sites..... 23

Introduction

A special operations team captures a “local.” With only one-week of language training, the local is told, in fluent grammar, to watch a small screen with pictures on a hand-held device while another soldier holds a probe by the local’s head. As the pictures change to scenes related to a suspected terrorist training camp, the probe blinks green. The local is taken back to base camp and through a series of tests reveals the location of the terrorist camp and confirms the individuals that have trained there. The local is then injected with a drug that short circuits the long-term memory creation process. When he wakes up, he has a bad headache and has a memory of falling down a hill and bumping his head. Year: 2035.

Location: anywhere in the world ...

In future wars, the ability to directly influence the enemy’s mind will be a reality. With technological breakthroughs, the reality of understanding the human brain has increased dramatically over the past 20 years, and amazing advances are being made daily. These changes are accelerating the creation of a whole new venue for peace and war. The “weapons of the mind” that were only dreamed about in previous conflicts will become operational. While these weapons will not entirely replace the classical method of fighting, there will be niche capabilities that will introduce significant threats for the United States.

Sun Tzu believed fighting a war involved much more than battlefield engagements; his primary target was the mind of the opposing commander. By concentrating on the mind of the enemy, combatants may not even have to fight physical battles to win a war. “To subdue the enemy’s army without fighting is the acme of skill.”¹ Clausewitz also espoused this approach when he stated, “an accurate and penetrating understanding [of the enemy] is a more useful and essential asset for the commander than any gift for cunning.”² Throughout history, military leaders tried to get “into the head” of their adversary and lamented that the ability to directly enter a person’s mind to effect change simply did not exist.

Combatants used indirect approaches, ranging from killing to intimidation, to undermine faith in leaders,

¹ Samuel B. Griffith. *Sun Tzu The Art of War*. London: Oxford University Press, 1963, pg 9.

² Clausewitz, Carl Von. *On War*. Princeton, NJ: Princeton University Press, 1984, pg 203.

dissuade personnel from fighting, or compel others to stop fighting. It is universally understood that the ability to know what the enemy is thinking is the ultimate intelligence; prior to today's technology, it was impossible to get. But the times are changing rapidly and what once was a dream may shortly become reality.

This paper explores the future capability to influence the mind directly, and it explores the capability to read thoughts and to insert/delete thoughts. Furthermore, it discusses the strong economic and moral case to create these technologies and makes predictions on future military usefulness as these technologies are adapted to military purposes. However, it also clarifies that there are several obstacles in the way, so

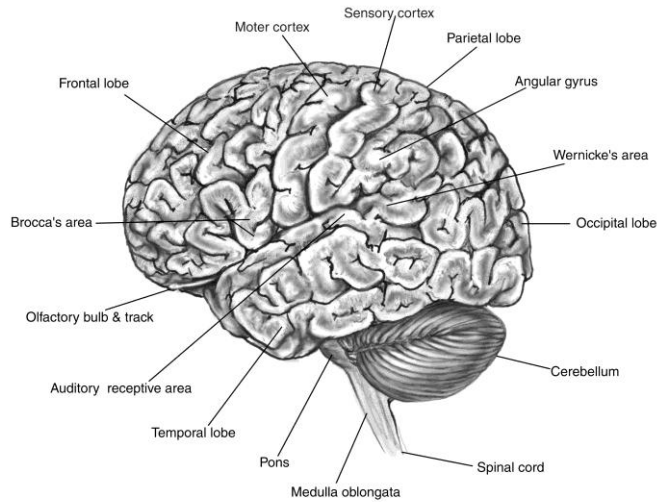


Figure 1: Areas of the brain

there should be no misconception about the difficulty of employing these technologies. Overall, the research seeks to answer the following question: What capabilities to directly manipulate the brain will exist in the year 2035 and what are the threats posed?

Section 1: The economic and moral case to fix the brain

At first thought, it might seem absurd that the world would create a weapon to invade the privacy of the mind. Such a weapon would be unethical, and for many, it is purely science fiction. The key premise of this paper is that the technology to create a mind weapon is being developed not for military purposes but due to valid and compelling economic, medical, moral and rationale reasons. It will not arrive in a sudden burst of new technology but slowly evolve over time solving one small problem at a time.

Those problems include many diseases or conditions that physically impair or restructure the brain, such as Alzheimer's, Parkinson's, and Autism, and in addition to natural causes of mental health difficulties, there are many man-made accidents that cause brain difficulties. The individual and societal suffering caused by these difficulties provides a strong rationale for finding ways to mitigate, prevent, or cure these maladies. The challenge is large enough that world governments and communities are working towards solving these problems. In fact, societies are demanding that these advances be made, and while the technology created is for the best of reasons, the second and third order consequences are harder to see and present serious challenges to future leaders.

Beyond altruistic reasons to help people that are sick, there are economic reasons to fix brain difficulties. According to the Alzheimer's Association³, there are over 4.5 million Americans with Alzheimer's (estimated annual cost of \$100 billion and growing), and another 5.3 million Americans have brain-related difficulties such as Parkinson's disease, epilepsy, or traumatic brain injuries. The world is aligning resources to fix these difficulties. Based on

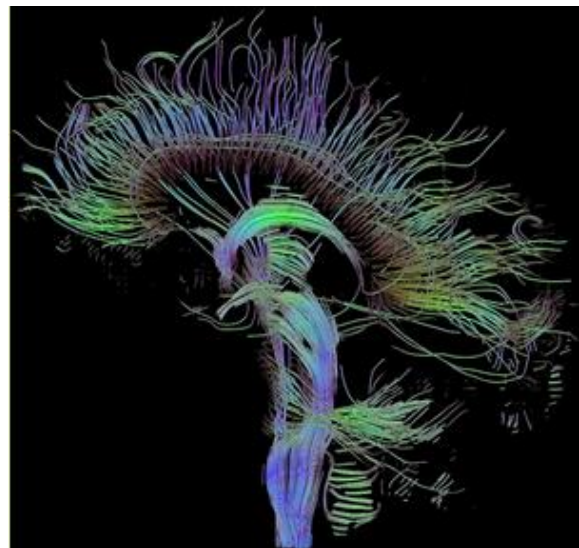


Figure 2: Brain Stem

statistics from the Mental Health Commission, conducted in 2003⁴, the Department of Health and Human Services spends nearly \$24 billion each year on mental health services. Total spending by the US government for mental health was \$100 billion⁵. Expanding beyond the US, the World Health Organization noted that 53.5% of countries⁶ developed

³ Handelman, Stephen. "Memory Hacker." Popsci.com, 3 Apr 2007. <http://www.popsci.com/scitech/article/2007-04/memory-hacker>. (pg 2)

⁴ Hogan, Michael F. *Achieving the promise: Transforming Mental Health Care in America*. Washington DC: President's New Freedom Commission on Mental Health. 22 Jul 2003. <http://www.mentalhealthcommission.gov/reports/FinalReport/toc.html>

⁵ National Expenditures for mental Health Services and Substance Abuse Treatment 1993-2003, <http://www.samhsa.gov/spendingestimates/samhsafinal9393.pdf>, pg 13

⁶ World Health Organization. *Mental Health Atlas 2005*. Geneva: World Health Organization. 2005. http://www.who.int/mental_health/evidence/atlas/global_results.pdf, Pg 15, 24

mental health programs in the 1990's. Also, around 70% of the world's countries have a specific budget for mental health. While there were no specific spending amounts mentioned in the report, it is clear that governments are getting involved in promoting mental health, and as they get involved, new discoveries about the brain will unlock capabilities to manipulate the brain.

In addition to fixing problems that deteriorate mental abilities, there are those that want to enhance the current powers of the mind. Making a person 10% smarter could pay huge dividends in today's competitive and knowledge-centric world. This type of research will further add to the growing wealth of knowledge about how the mind works. These technologies, their progress, and future are explored in Appendix 1.

Through the process of organizing and focusing their research and resources on solving real-world problems or enhancing abilities, small advances, but cumulatively significant, will occur and each step will seem logical, morally constrained and necessary. Only in hindsight will the startling nature and potential of this new technology become apparent. Some may contend that moral virtues will limit proliferation of the weaponized technology but morality is defined differently throughout the world and once the technology is out, there will be no way to stop it. In other words, it is inevitable that this type of technology is developed and therefore it is best to think about it now to help control or shape where the tech is going.

In the case of militaries developing weapons of the mind, they will adapt the technologies created for the benefit of mankind. Governments and militaries around the world will watch the worldwide sharing and progress of technological discoveries by academic, medical and commercial sectors. However, once a particular capability is created that can reliably provide direct influence of the brain; history indicates people will quickly adapt the technology for militaristic use.

Section 2: A good map will get you there

Since humans developed self awareness, there has been an interest in knowing how the brain works, how to fix the brain, and how to improve the brain. According to the National Institute of Mental

Health,⁷ the 1990's were the "Decade of the Brain" and the decade beginning in the year 2000 was the "Decade of Discovery." During these two decades, an understanding of the brain grew rapidly due to new imaging technology, and additional knowledge is growing at an accelerated pace.

Prior to the 1990s, the study of the brain was relatively limited to the "art" of understanding the brain, best represented through psychology, but since the 1990s, the "science" of the brain has expanded rapidly to enable a significant improvement in understanding the processes and functions of the brain. In the early 1990s, the functional magnetic resonance imaging (fMRI) vastly improved neurological information⁸ by allowing a visualization of the brain that specifically identifies how things change.

With the ability to "see" the functioning brain with the fMRI, scientists throughout the world united to create a human brain mapping project. The Organization for Human Brain Mapping⁹, started in 1995, serves as the international organization for sharing of information on the latest discoveries in mapping the brain. The International Consortium for Brain Mapping¹⁰, started in 1993, links four universities that established neuroinformatics and databases for collecting information. The BrainMap¹¹ created a database to capture a functional schematic of the brain. Because of the unprecedented information sharing and organization throughout the world via the internet, the science of understanding the brain is growing exponentially.

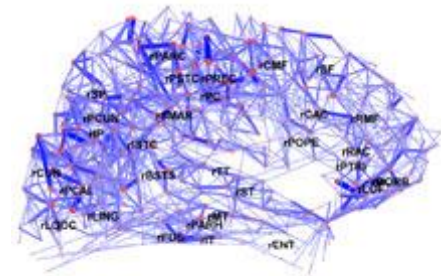


Figure 3: Brain imaging to build a map of the cortical architecture

A rapidly expanding knowledge of the brain will synergize with the increasing understanding of non-biological enhancements, as well. To prevent rejection by the body, scientists have shown that rat

⁷ The National Institute of Mental Health Strategic Plan, <http://www.nimh.nih.gov/about/strategic-planning-reports/index.shtml>

⁸ A life saving window on the mind and body, the development of Magnetic Resonance Imaging, <http://www.beyonddiscovery.org/content/view/article.asp?a=129>

⁹ The Organization for Human Brain Mapping, <http://www.humanbrainmapping.org/i4a/pages/index.cfm?pageid=1>

¹⁰ International Consortium for Brain Mapping, <http://www.loni.ucla.edu/ICBM/>

¹¹ BrainMap website, <http://brainmap.org/>

brains can accept nanowires¹², which is critical in learning how brains can successfully accept non-biological enhancements. Other scientists are working on chips to plug into the brain; one experiment tested a chip replicating 12,000 neurons and it “speaks” to a rat brain as if it were a regular body part¹³. Over 150,000 people already have straight-to-the-brain cochlear implants rather than traditional hearing aids.¹⁴ To enable these future neural implants, other scientists are creating a battery-free power source¹⁵. In a move that could potentially speed this research, others are determining how the brain can interface with computers¹⁶. In fact, some scientists are predicting that by 2020, the ability to control computers with brain waves will exist.¹⁷ Once the brain can directly interface with computers and the internet, novel capabilities will literally occur at the speed of thought. Enhancements that include mobile access to the internet via a small chip in your brain, artificial intelligence augmentation, and thought-control of electronic devices are all feasible. While non-biological technology is not specifically addressed in this paper, the key thing is that these areas of research will aid a rapid accumulation of knowledge about the brain.

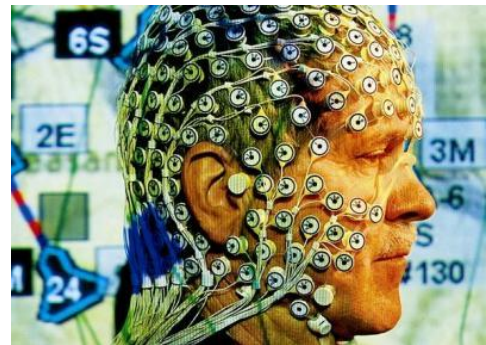


Figure 4: The Army's thought helmet experiment

The technology to manipulate the brain will be available sooner rather than later. Although some may say that humans have tried to understand the brain since they could think, it was not until the mid-1990s that a technical understanding of the brain began to rapidly expand with the creation of the fMRI. Coupled with information sharing via the internet and focused governmental and non-governmental organizations, knowledge about the brain is increasing at an even faster rate. Additionally, non-biological

¹² A step towards better brain implants using conducting polymer nanotubes, <http://www.physorg.com/news173465029.html>

¹³ Handelman, Stephen. “Memory Hacker.” Popsi.com, 3 Apr 2007. <http://www.popsi.com/scitech/article/2007-04/memory-hacker>.

¹⁴ Kleim, Brandon. “Brain-Machine interfaces makes for tricky ethics.” Wired.com, 25 Feb 2009. <http://www.wired.com/wiredscience/2009/02/brainmachine/>

¹⁵ Green, Kate. “A battery-free implantable neural sensor.” Technologyreview.com, 5 Nov 2009. <http://www.technologyreview.com/computing/23878/?a=f>

¹⁶ James, Chris. “Communicating person to person through the power of thought alone.” University of Southampton, 6 Oct 2009. http://www.soton.ac.uk/mediacentre/news/2009/oct/09_135.shtml

¹⁷ Gaudin, Sharon. “Intel: Chips in Brain will control computers by 2020.” Computerworld.com, 19 Nov 2009. http://www.computerworld.com/s/article/9141180/Intel_Chips_in_brains_will_control_computers_by_2020

technologies are adding exponentially to the store of information. Together with the moral and economic perspectives, there is a perfect environment for creating brain-manipulating technologies. The next two chapters look specifically at two potential weapons of the mind that may exist in 2035.

Section 3: A penny for your thoughts

“How often have you wondered what your spouse is really thinking? Or your boss? Or the guy sitting across from you on the bus? We all take as a given that we'll never really know for sure. The content of our thoughts is our own - private, secret, and unknowable by anyone else. Until now, that is.”¹⁸

Technology today:

The ability to literally get inside somebody's head would offer a dramatic increase in not only the ability to understand but also to influence intentions and behavior. This ability is critical for medical personnel to progress from the “art” of fixing the brain to the “science” of fixing the brain; knowing which memories are lost or still there is akin to a doctor knowing the virus that is infecting the body rather than guessing at the virus by understanding the symptoms. Significant work is being done to better understand what a person is thinking and there are several technological developments that show promise in this area.

One technological approach to reading minds is to have the brain confirm the existence of a memory. By showing a picture to an individual, will the brain respond in a standardized way if the person had seen the content of the picture before? The FBI developed a system to do just that - the brain will trigger on a positive memory. In FBI tests, it was 100% accurate, and did not give any false positives, false negatives, or indeterminates. In 2001, the FBI demonstrated that this system could detect terrorists¹⁹ and by manipulating the pictures, other “types” of people can be identified. While this form of technology might not be considered reading thoughts, it is a technology that exists today that can determine whether certain memories exist in the brain.

¹⁸ Stahl, Leslie, “How technology may soon read your mind.” CBS 60 Minutes, 26 Jun 2009.

<http://www.cbsnews.com/stories/2008/12/31/60minutes/main4694713.shtml>

¹⁹ Kirsh, Steve. “Identifying Terrorists before they strike” KurzweilAI.net, 2 Oct 2001.

<http://www.kurzweilai.net/meme/frame.html?main=/articles/art0331.html>

While scientists typically avoid the word “mind reading,” there are scientists that are “neural decoders.” Their progress is amazing considering the few short years the technology has existed to truly enable these types of experiments:

1. In March 2008, scientists created a crude reproduction of a movie that a test subject was watching - by monitoring their brain waves²⁰. After monitoring the subject’s brain activity while watching two hours of video clips, the subjects were then shown new clips and the computer program, based on the neural map of previous brain responses, created a representation of the brain activity. While the results were not Hollywood renderings, the approach was successful in extracting crude images from the brain.
2. Unlike the previous experiment, in December 2008,²¹ test subjects were shown a “selection of images made up of black and white squares on a 10x10 square grid,” while having their brain scanned. By establishing this baseline of memory patterns, the analytical process of reading memories was not limited to a selection of previously recorded images, rather, it allowed the experimenter to “read” anything that someone was thinking.
3. By showing a number or dots to a person and then imaging the brain with an fMRI, it was possible to determine what number (or number of dots) the person saw.²² This particular test demonstrates a pattern for how numbers are encoded in the brain, and provides support in determining exactly how the brain stores memories.

²⁰ Callaway, Ewen. “Brain scanners can tell what you are thinking about.” Newscientist.com, 28 Oct 2009. <http://www.newscientist.com/article/mg20427323.500-brain-scanners-can-tell-what-youre-thinking-about.html>

²¹ Biever, Celeste. “Mind-reading software could record your dreams.” Newscientist.com, 12 Dec 2008. <http://www.newscientist.com/article/dn16267-mindreading-software-could-record-your-dreams.html>

²² Cell Press. “Cracking The Brain's Numerical Code: Researchers Can Tell What Number A Person Has Seen.” Sciencedaily.com, 25 Sep 2009. <http://www.sciencedaily.com/releases/2009/09/090924123306.htm#>

These types of experiments are making great strides in improving the understanding of how the brain can be read. The brain's method of storing memories is a pattern that can be learned, understood and copied. Both of the approaches discussed in this paper are based on pattern matching in the brain, so, while the ability to extract specific thoughts from an un-baselined person's brain seems far away, the technology is continually improving.

Technology Patterns in 2035:

By 2035, there will be significant advances made in the area of reading minds. The ability to positively identify personnel by their brainwaves and potentially determine intent, based on their past experiences, will be a reality by 2035. For example, an airline passenger can be identified today for entrance into the secure area of the airport, but it is hard to determine if the person has bad intentions; in the future that might not be as challenging. The science of pattern recognition will continue to be improved, and as other technologies evolve, such as nanotechnology and computers, the ability to "plug a brain into a computer" will create additional synergistic capabilities to read thoughts. Therefore, it can be expected that the science of being able to read thoughts will continue to grow significantly, but by 2035, the technology will still heavily depend on pattern recognition approaches.

Unlike science fiction, there will be drag and friction as this technology matures. For the same reason that patients can reject transplanted organs due to incompatibility, the mind's natural defenses and uniqueness will require brain-reading weapons to be customized to the individual. This customization will significantly raise costs over generic medical tools, making brain weapons relatively expensive. An even more challenging drag hampering new approaches will be the moral implications of this research. This concept will be very difficult for many people to accept. The science is scary, the moral implications substantial, and the invasion of privacy unparalleled. However, the technology will progress because people will view it as more amoral to not fix or reduce the difficulties with the human brain such as dementia. Furthermore, even if some technologies are viewed as immoral in this country, other countries are not precluded from furthering research in that area. Lastly, due to the combination of resources and expertise, nations and large organizations with a medical focus will create the main technological

advances; however, smaller groups or individuals will potentially be able to adapt or synergize the technologies more quickly into specific functional applications and with greater flexibility and far less constraints. In spite of the economic, morale, and organizational obstacles, the capability to read thoughts will continue to grow and develop.

Threats:

The mind may be the last bastion of true privacy in the world; however, by 2035, there will be ways of opening up the mind for all to see. While the medical/commercial world looks for economic viability and applications that can be used for mass service, militaries and rogue actors will only need specific, niche functionality to create weapons of the mind that will have devastating effect.

1) Finding the spy: In the same way that airplanes today can broadcast an Identification Friend or Foe, the future will hold the ability to determine if individuals are friendly or not. By perfecting experiments on brainwave identification and intent, the ability for others to know who the spies are or who is sympathetic to a cause will make Human Intelligence collection significantly more difficult. The ability to accurately know who is friend or foe will change the way combatants collect information on their enemies.

2) Legal proceedings: In 2008, a woman was convicted in India of murder after an EEG of her brain allegedly revealed that she was familiar with the circumstances surrounding the poisoning of her ex-fiancé.²³ Imagine the courtroom of 2035 where brain scans can accurately reveal both fact and intent. While swift identification of bad actors is good, this can also be used against military personnel accused of crimes or captured in foreign countries. This information could easily be exploited for negative publicity, military information or influencing the

²³ Stahl, Leslie, "How technology may soon read your mind." CBS 60 Minutes, 26 Jun 2009. <http://www.cbsnews.com/stories/2008/12/31/60minutes/main4694713.shtml>

individual's behavior. In today's world, the "truth" can sometimes be hidden, but in the future, it may be significantly more difficult.

3) Kidnapping: While kidnapping today is mainly done for financial reasons, in the future, the opportunity to extract valuable information will become just as important. For example, personnel with a security clearance or specific knowledge about a subject now become a greater vulnerability. Kidnapping them, positively identifying their knowledge awareness, then taking them to a location that could extract additional information will result in windfalls of information. In a world where knowledge is a strong currency of power, the ability to be a robber of the mind will open up a lot of vulnerabilities. Coupled with the ability to "forget" the kidnapping (see below), this becomes a very dangerous scenario.

As outlined above, the most dangerous threats in 2035 will deal with the inability to conceal information, rather than specifically reading a random thought from a stranger. However, with the continuing pace of technology, it is possible to envision some crude forms of information retrieval systems, built primarily for medical purposes, which will be warped into weapons designed to extract and understand specific thought patterns.

Section 4: Winning Hearts and Minds

Since combat first began, psychological preparation of the battle space was an important factor in determining the victor. "Psychological operations...have proven to be indispensable...it allowed us to apply a type of power without necessarily having to shoot bullets."²⁴ Instilling fear in the enemy might induce the adversary to surrender before the fighting, or reduce the duration of the battle. In Vietnam, specific psychological operations were designed to encourage potentially friendly personnel to stay friendly and entice the not-so-friendly to become friendly. In Afghanistan, the consequences of wartime mistakes such as bombing a gas truck surrounded by civilians, have a devastating impact on the

²⁴ Birdy, Andy Col. "Psychological Information (FM 3-05.30)." Apr 2005, pg 1-1.
<http://fas.org/irp/doddir/army/fm3-05-30.pdf>

perceptions of ordinary people. In this section, the ability to directly create or delete memories is explored.

Technology today:

The same technology that expands an understanding of reading memories will also help develop ways to create or delete memories. In the same way that doctors first learned about the heart and are now able to replace it if it goes bad, doctors will learn specifically how the brain functions and memories are stored - and then be able to manipulate them. Currently, learning how memories are stored is an important research area, but there are already experiments looking at how it might be possible to create and delete memories.

In Jun 2009, a biochemist watched as proteins were connected between neurons to create a long-term memory²⁵. As one scientist stated, "What's really different here is being able to look at a memory being formed at the level of individual synapses." While the memory was seen in a sea slug, rather than a human brain, the sea slug was chosen because its brain patterns are similar to that of humans. This sort of technological advance will open additional research on gaining a better understanding of the physical aspects of how a memory is created and stored.

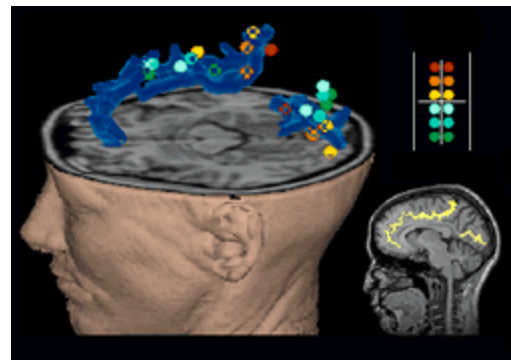


Figure 5: Future memory scanning

In Oct 2009, scientists created false memories in flies²⁶. By isolating 12 cells associated with a certain type of learning, scientist were able to genetically create flies that had their “dopamine-producing brain cells manufacture a membrane protein called P2X₂ that was sensitive to laser light.” After flashing these flies with a laser, causing the P2X₂ to activate, these flies avoided a certain smell. "Stimulating just these neurons gives the flies a memory of an unpleasant event that never happened." In a different experiment, scientists were able to change proteins in mice that either erased the memory or prevented its

²⁵ Moskowitz, Clara. “Scientist gets first image of memory being made.” Foxnews.com, 29 Jun 2009. <http://www.foxnews.com/story/0,2933,529187,00.html?sPage=fnc/scitech/naturalscience>

²⁶ Barley, Shanta. “Laser creates false memories in fly brains.” Newscientist.com, 15 Oct 2009. <http://www.newscientist.com/article/dn17990-laser-creates-false-memories-in-fly-brains.html>

recall.²⁷ Comparing these experiments to the human brain, scientists stated, “As a general rule, biology tends to be conservative and it's rare that evolution 'invents' the same process several times.”²⁸ In other words, generic rules of biology, such as the behavior of proteins, apply to fly brains as well as human brains; therefore, the studies such as these reveal significant information on memory formation.

In a world where some memories should not be remembered, such as events causing post traumatic stress, the erasing of memories could help return people to normalcy. While there appears to be fewer initiatives to create or delete memories than the ability to read memories, the technology is certainly progressing. However, there are some significant hurdles for this technology to increase rapidly.

Technology Patterns in 2035:

The ability to create, delete or read memories will grow synergistically, although not necessarily at the same pace. To create or delete memories, the science is more difficult and a better understanding of the physical characteristics of a memory is required. One theory to create/delete memories is based on treating the brain like a computer. If a file or memory is bad, then delete it; or if a file was accidentally deleted, then restore it. An improved understanding of the physical properties of memories will enable them to be deleted or created, but there will be friction to the advance.

There are two main friction points: morality and brain filters. While moral objections to reading thoughts will be overcome more easily, the moral objections to creating or deleting thoughts will be very strong due to the perspective of directly manipulating somebody's memory. However, technological advances in reading memories will open up the capacity for creating and deleting memories; they are linked together and progress in one will enhance the other. Beyond the moral dilemma of this technology, the science of memory creation/deletion will be complicated by the brain's massive redundancy and contextual filters. To delete/add a memory might be much more complicated than simply deleting/adding a file from a computer, because it is still unknown exactly how the sight, sound, smell,

²⁷ Callaway, Ewen. “Eternal Sunshine drug selectively erases memory.” Newscientist.com, 23 Oct 2008. <http://www.newscientist.com/article/dn15025-eternal-sunshine-drug-selectively-erases-memories.html>

²⁸ Genova, Cathleen. “Scientists give flies a bad memory.” Medicalnewstoday.com, 17 Oct 2009. <http://www.medicalnewstoday.com/articles/167688.php>

and context of a memory are stored and where. Will the brain's filter realize that the inserted memory lacks specific details, such as smell, and throw it out? Furthermore, if the inserted memory is contrary to a cultural norm or a known bias, will the individual's thought process discount it in the same way that we can discount a news report that is contrary to popular beliefs? The brain is like a computer with multiple smart firewalls to protect it and this will create significant drag on the science of manipulating memories.

Threats:

In modern warfare, where a decreased number of unnecessary deaths are the new measure of merit, being able to convince a combatant not to fight would be a considerable advantage. In the future, technology will provide ways to introduce memories directly into the brain. As described above, the ability to insert/delete memories by 2035 will be limited, but that does not mean that there are no realistic threats from this capability.

1) Brainwashing: the process of brainwashing could take on an entirely new meaning in the future. By using a controlled environment and using direct and indirect memory creation, the effectiveness of this will be dramatic ... particularly for the creation of suicide bombers or radicalizing people.

2) Long-term Democratic Ideals: the ability to be free to think, even as a Prisoner of War, is a critical capability of mankind. The ability to insert/delete memories might become the weapon of choice in slowly influencing behaviors by reshaping how people think about things.

3) Forgetting: If a way is found to sever the short- to long-term memory process, or any other technique of preventing memory creation, then periods of forgetfulness could be created. This could have dire applications for committing misdeeds such as torture, crimes, or atrocities. When there are no witnesses, it will be hard to administer justice.

While the technology to create/delete memories will not be fully mature by 2035, the ability to directly manipulate the brain will be a tempting side trek as more is learned about how the brain works.

For some, this capability will present a moral dilemma, but for rogue groups with specific desires, the ability to experiment with mind manipulation will be tempting.

Section 5: Conclusion

“Future breakthroughs in neuroscience could have a great effect on society. What will the world be like when technology can tell us without a doubt that the accused is guilty of a crime, a spouse has cheated or an employee might steal? That is just the tip of the iceberg. How about uploading your memories for posterity or downloading the skills you need for that new job? Record your dreams for later viewing or control your computer (or any device), just by thinking about it. Many of these futuristic technologies are already in development.”²⁹

This paper contends that three compelling forces will create an irresistible force in bringing forth the technology that will enable mind weapons. There are a multitude of technologies, such as artificial intelligence, nanotechnology, mind enhancement, and medical research, that will synergize together to form new capabilities. Additionally, a strong social requirement to cure/fix problems with the brain will provide moral advocacy and financial backing for the technological advances. Lastly, these technologies are being pursued by many nations and groups that are lashed together via the internet creating rapidly shared information and advances. These factors will overcome any moral dilemma associated with manipulating the brain; therefore, science fiction will become science fact.

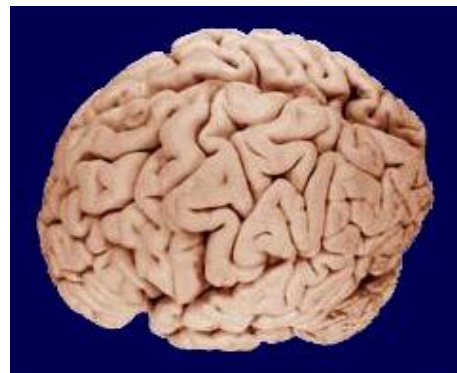


Figure 6: The brain

Because weapons of the mind will be created, there will be changes to warfare in 2035. As Sun Tzu desired, the ability to know the mind of the enemy will be opened up. The art of intelligence collection will become very personal; this is particularly applicable in the counter-insurgency fight where the enemy is elusive and blends in with the crowd. This technology will also make huge dents in the war

²⁹ “The Brain and Mind.” http://www.futureforall.org/brain/brain_mind.htm

on drugs, revealing carriers and suppliers. The key point is that the weapons of the brain will still be used at the tactical, individual level of war, such as fixed or mobile scanning stations, but the information gained will have strategic impacts. In the future, the fog of war may very well be redefined when mind weapons are introduced.

On the other hand, this technology will also create abilities for those that want to fight the United States. Every individual that knows something important could be at risk, and for a knowledge-centric world, that is a considerable risk. Anything from economic information to military secrets could be revealed with improved clarity. One of the greatest threats in the future, from the lens of today's counter-insurgency fight, will be the capture of a military person. If the technology to create/delete memories is used, the military person might be returned, but what he is thinking may be very different from before his capture. The most dangerous scenario will occur when a person is taken, reveals information, and then has their memory erased so that the victim does not remember anything about the incident. Manipulating memories will be a powerful tool for those that do not want to live within the law. The science fiction novel The Manchurian Candidate will be turned into science fact.

This paper makes projections about future capabilities that will exist in the year 2035. Even though the technology to learn about the brain did not really start until the early 1990s, the collective understanding of the brain has grown rapidly. The technological experiments of today provide a glimpse at the possibilities of the future and this paper has outlined two specific areas of study: reading thoughts, and creating/deleting thoughts. While the focus of this paper has been on changing the natural state of the brain, a collaboration of this research with non-biological enhancements to the brain will create breakthroughs. Furthermore, the moral dilemmas of this technology will be overcome by the desire to heal the sick. It is time now to start thinking about ways to minimize and deter the vulnerabilities that this technology will create in the future.

Appendix 1: Going back to school

Flash forward a decade and a half from today...[your daughter] has taken on her most formidable challenge yet, competing with her generation's elite in her fancy new law school.

...
How does she explain what the enhanced kids are like?

...
They have amazing thinking abilities. They're not only faster and more creative than anybody she's ever met, but faster and more creative than anyone she's ever imagined.

...
They all have photographic memories and total recall. They can devour books in minutes.

...
They have this odd way of cocking their head in a certain way whenever they want to access information they don't already have in their own skulls—as if waiting for a delivery to arrive wirelessly.

...
Her new friends are polite when she can't keep up with their conversations, as if she is handicapped

...
... they call her—"Natural"... They call themselves "Enhanced."³⁰

Technology today:

Beyond reading, creating, and deleting memories, the ability to learn things quickly and efficiently is a skill that is highly desired in today's world where knowledge is a strong currency. The ability to enhance physical performance, such as drinking protein shakes or taking steroids, has been around for a while, and the ability to enhance intellectual performance is desired. There are many technologies focused on helping people to become smarter.

Scientists are working on pills to create a photographic memory³¹. Spanish scientists isolated the RGS-14 protein that dramatically increased memories in mice, from a few hours to 2 months. In these experiments, the goal was to focus specifically on information that is visually presented to the brain. They were able to create a 1,500 percent improvement in memories that were created through the visual cortex of the brain.



Figure 7: Testing on drugs for enhancing brain power

³⁰ Garreau, Joel. *Radical Evolution*. Doubleday, 2005

³¹ Smith, Dan. "Coming soon: photographic memory in a pill." Popsci.com, 6 Jul 2009.

<http://www.popsci.com/scitech/article/2009-07/memory-problems-new-drug-could-give-you-photographic-memory>

For those that wish to improve their memory while sleeping, there might be some hope. Scientists are also working on a nasal spray that will increase memory retention³². By reading before bed, then using the spray, the retention of memories is increased. By increasing an interleukin-6 immune system molecule, the brain can retain emotional and procedural memories during Rapid Eye Movement (REM) sleep. This approach helps the body's sleeping process achieve greater retention of important information, and it increases understanding about sleep-dependent formation of long term memories.

Most people understand that repetitive training will lead to better retention of information than cramming. In a study to look at these two forms of training,³³ scientists discovered that the Kinase C Apl II enzyme that is activated in cramming that might block the formation of long-term memory creation, while allowing the creation of short-term memories. Manipulating the body's natural chemistry may lead to greater memory retention

In another study of changing physiology to improve memory, scientists have found a gene to increase memory retention³⁴. In rats, scientists overexpressed the NR2B gene that resulted in memories being retained three times longer than the average rat. The NR2B gene allows brain cells to communicate a fraction of a second longer than normal, potentially strengthening the formation of the memory. The NR2B gene shows great promise as the "universal switch for memory formation."

Of the three capabilities discussed in this paper, the particular area of enhancing intelligence will be the most developed. While this paper does not discuss non-biological enhancement to the brain, the enhancement of the natural brain will create tremendous improvements in the ability to learn new information.

³² Federation of American Societies for Experimental Biology. "Scientists develop nasal spray that improves memory." Sciencedaily.com, 2 Oct 2009. <http://www.sciencedaily.com/releases/2009/10/091001091752.htm>

³³ McGill University. "Why one way of learning is better than another." Sciencedaily.com, 2 Oct 2009. <http://www.sciencedaily.com/releases/2009/10/091001163730.htm>

³⁴ Medical College of Georgia. "Smart rat "Hobie-J" produced by overexpressing a gene that helps brain cells communicate." Sciencedaily.com, 20 Oct 2009. <http://www.sciencedaily.com/releases/2009/10/091019122647.htm>

Technology Patterns in 2035:

Whereas the previous capabilities (reading and creating/deleting thoughts) were motivated in large part due to medical desires to fix brain difficulties, this particular area (i.e. improving the ability to learn) is motivated by not only medical desires but also the competitive nature of mankind. Students of any knowledge-based endeavor will seek an advantage in learning more and faster than others. Therefore, a significant amount of time and effort will be devoted to research in this area. As this paper states, there will be many natural enhancements to the human brain that allow individuals to learn more efficiently, more effectively, and faster. Furthermore, there is the potential of non-biological enhancements that speed that process even faster. Because of the competitive nature in the world, the research in this area will be significant and will open up many enhancements by 2035.

The technological advancements in this area will be bound by some ethical/moral questions; however, about the only true limit is on how much enhancement the brain can physically take, and we don't know that limit, yet. As people augment their intelligence, naturally or non-biologically, there will be an ethical debate about the definition of humanity. How much augmentation still allows you to be classified as a normal human being? The reason that this is important is because these augmentations will create an "enhanced" vs. "natural" divide, and processes such as entrance into a college or the military might need to be reviewed. Besides the moral issues, the effectiveness of learning enhancements will be slowed by the brain's defense mechanisms that resist change. For example, while some pills today may give a temporary boost in memory skills, the brain will normalize the drug after a while and it will cease to cause such a dramatic boost. Will drugs or natural enhancements have to be continually "strengthened" to maintain the same level of effectiveness? Is there a limit to how much the brain will accept before the enhancement starts to have negative side effects due to the potency? Overall, there are some scientific challenges that need to be overcome to ensure that a person's ability to learn is considerably improved over today's "standard" brain.

Due to the competitive nature of the world (school, business, research, etc.), this technology will blossom more than any other because not only will it be backed by medical research, but it will be funded

by all the “regular” people that want to become better. The market for selling “smart pills” is significantly larger than the pool of personnel that have brain illnesses; therefore, the demand will be greater. By 2035, the main technological advances will be in increasing the efficiency of retaining information from standard teaching methods, as well as creating a machine-to-brain interface to provide specific information. It must be noted that the ability to push data into the brain will be improved, but that doesn’t guarantee that the person’s wisdom will be any better. Will we end up with lots of highly intelligent but not very wise people?

Threats:

Learning faster and more efficiently is very important for most people in the world. Unfortunately, even great benefits to mankind can be turned into something that can hurt people. Therefore, a smarter world will bring some significant threats.

1) Insurgencies grow smarter: In today’s world, there is value and emphasis on finding members of an insurgency with great technical skills, such as a master bomb maker. When knowledge can be more easily passed from one person to another, the future combatant will face a potentially smarter enemy. The ability to share critical technical expertise will create a deadlier enemy.

2) Dependency creates vulnerability: As military personnel, students, business leaders and others seek an “edge” in the intellectual battle, will they become reliant upon the enhancements? Significant vulnerabilities will occur if the production of the enhancements is corrupted or manipulated to cause a side effect. If the US society in general tries to become smarter with drugs or non-biological enhancements, then a much larger vulnerability would be created.

Despite the threats, this is a huge growth area for technology and in the end, the technology will press forward. Over the next two decades, there will be tremendous advances in this area because most people want to become more competitive, and learning faster/better than others creates a valuable and marketable skill.

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(good views on pros/cons of this type of work)

<http://www.medicalnewstoday.com/sections/neurology/> a good website to look for current information
(continually check this website)

<http://neuroscience.ucdavis.edu/> (potential resource site)

<http://www.technologyreview.com/biomedicine/23695/> (intelligence explained) ... awaiting purchase

http://libach.inrf.uci.edu/groups/bats/uploads/Implants/Brain_Interface_2006.pdf
challenges and possibilities for brain implants ... long read

<http://ebird.osd.mil/ebfiles/e20091110715404.html> article about scanning for PTSD (i.e. looking for changes)

<http://www.physorg.com/news177005525.html> (theory about short/long term memory)

- <http://www.sciencedaily.com/releases/2009/10/091022101544.htm> (brain can “clean” nano wires that disconnect)

- http://www.wired.com/magazine/2009/10/mf_optigenetics/all/1 (optics for controlling and connecting to the mind)

- <http://www.technologyreview.com/biomedicine/23767/> (more on optogenetics)

The neural correlates of religious and non-religious beliefs,

<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0007272#abstract0>

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Drug enhancement of memory

<http://ntsa.metapress.com/app/home/contribution.asp?referrer=parent&backto=issue,90,167;journal,7,12;inkingpublicationresults,1:113340,1>

(DARPA project for cognitive enhancement) ... article purchased & on hard drive.

<http://www.ingentaconnect.com/content/jbp/pc/2008/00000016/00000002/art00001>

technologically enhanced learning ... buy this one.

<http://www.sciencedaily.com/releases/2009/11/091109173600.htm>

Stem cells restore cognitive ability after brain tumor

<http://www.sciencedaily.com/releases/2009/11/091110105347.htm>

Scientists decipher the formation of long-term memories

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to make new memories, old ones need to be deleted

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<http://hplusmagazine.com/articles/ai/race-reverse-engineer-human-brain>

Race to reverse engineer the human brain

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Blindness causes brain restructure, implying brain can adapt

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Scientists advance understanding of stem cells ... for the brain

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website that discusses the future of lots of technologies