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Neurotechnologies and Future Warfare

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SYNOPSIS

With recent developments in emerging technologies such as artificial intelligence and neurosciences, technology is increasingly becoming autonomous and intrusive. The growing reliance of technology as surrogate in warfare raises serious ethical and accountability issues.

COMMENTARY

LAST AUGUST, Elon Musk delivered a presentation about his latest company Neuralink and showcased a small implant that could read and transmit the neural activity of a pig. While his presentation attracted a lukewarm reception on behalf of neuroscientists, because the technology presented was already known, Neuralink's demonstration showcased the growing interest in neurotechnologies from both the private and military sectors.

Neurotechnology can be defined as devices and procedures that are used to access, monitor, investigate, assess, manipulate, and emulate the structure and function of neural systems. Neurotechnology devices interface with biological nervous systems in order to monitor, assist or enhance the cognitive processes executed by those systems. Unlike artificial intelligence systems that seek to emulate or simulate functional aspects of the human brain, neurotechnologies are designed to record, monitor, functionally understand, and modulate processes in the brain.

Military Applications of Neurotechnologies

Three categories of military applications of neurotechnology can be identified. The *first* category relates to the enhancement of the warfighters' capabilities through various forms of transcranial electric stimulation technology. For instance, there is a wide range of possible military applications dealing with soldiers' mood disorder and with increasing resilience to stress and other emotions that impact their behaviour on the battlefield.

The US Defence Advanced Research Projects Agency (DARPA) is also conducting research to treat soldiers and veterans with depression and post-traumatic stress disorders. Also being researched is mapping brain activity related to concentration and empathy so as to develop algorithms to stimulate these specific conditions. DARPA has also been conducting research on targeted neuroplasticity training to speed up learning processes for service members and other defence officials.

The *second* category comprises neurotechnological systems for deception detection and interrogation capable of accessing concealed information in response to a stimulus. Medical diagnostics techniques such as functional magnetic resonance (fMRI) and electroencephalography (EEG) can here also be used as surveillance and interrogation tools. In these cases, brain-based lie detection technologies associate the truth-values of an uttered sentence or a mental state with specific patterns of brain activity.

The *third* category, which also offers the widest range of military applications encompasses systems that establish a direct connection between the brain and an external device through brain-computer interfaces (BCIs).

A BCI is a system that measures the activity of the central nervous system (CNS) and converts it into an artificial output that replaces, restores, enhances, supplements, or improves natural CNS output, and thereby changes the ongoing interactions between the CNS and its external or internal environment.

In other words, a BCI enables interaction between the human brain and a machine, enabling the user to interact with a computer/machine with only the power of thought. BCIs can be used in various ways. Prosthetic systems, for example, can be used for cognitive and memory enhancement.

Synthetic Telepathy & 'Brain Hacking'

In November 2017, the University of Southern California conducted an experiment, in which for the first time a brain implant effectively improved human memory by increasing the working memory by 25% and the short-term memory by 15%. DARPA has also been testing memory-enhancing implants as part of the BRAIN Initiative, reaching significant improvements of short-term memory as far as 35%.

Other DARPA memory enhancement-related projects include Restoring Active Memory an implant that would facilitate the formation of new memories and the retrieval of existing ones.

BCIs can also extract information from the brain and communicate directly through interfaces, also known as synthetic telepathy. Experiments have shown that intended and covert speech could both be detected and subsequently translated by BCI software. Cross-species experiments have shown the possibility of synthetic telepathy, or mind-control, from the human brain to an animal tail.

While brain to brain communication is still in its earliest stages, further developments could lead to the reality of mind control for various purposes and its intentional military use to control and extract information from the brains of soldiers or adversaries.

Another frightening development could see the emergence of "malicious brain-hacking". This refers to the possibility of co-opting brain-computer interfaces and other neural engineering devices to access or manipulate neural information from the brain of users.

Future Warfare: Human-Machine Teaming

In the immediate future, one of the most likely competitive advantage of BCIs in warfare will be in the area of human-machine teaming. In 2015, DARPA enabled a quadriplegic woman to control an F-35 fighter jet in a simulator, using only brain receptors. In 2018, the experiment was extended to combine advancements in AI, swarm technology and BCI.

In a simulation, DARPA's research indeed enabled the control of three aircraft simultaneously through a brain chip. In a significant development, DARPA improved the interaction between pilots and drones by not only allowing the pilot to send but also receive signals from the controlled crafts.

These developments support the research of swarm of drones and the emerging operational concept of "loyal wingman" which connects piloted aircraft with AI-driven drones in air combat operations.

For example, the US Air Force Skyborg programme, which seeks to develop an AI-based brain for its "loyal wingman" drones, is particularly interested in this technology. This research is, however, not limited to the United States, as Australia, China and Russia are also investing in human-machine teaming and "loyal wingman" concepts.

Going forward, these potentially game-changing technologies alter the character of future warfare. Accordingly, the international community should lose no time in coming up with a governance system of brain data – to prevent the malicious uses of neurotechnologies and regulate their military applications.

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