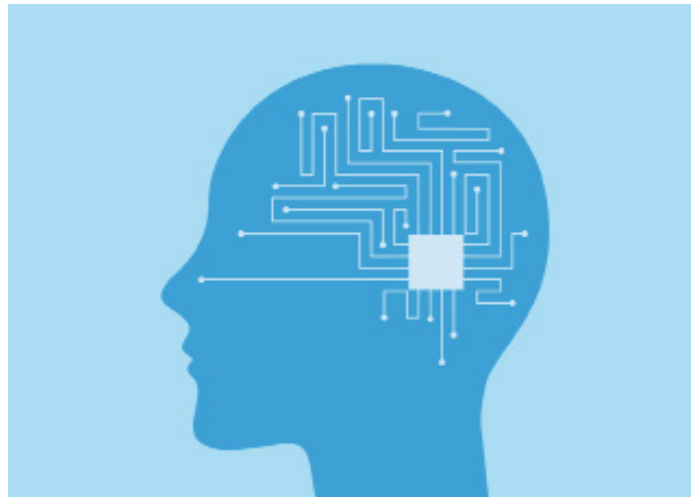


BRIEF OF THE SCIENTIFIC ADVISORY BOARD ON: NEUROTECHNOLOGY



WHAT IS NEUROTECHNOLOGY?

Neurotechnology is an umbrella term referring to any technology that records or modifies the neurons in the human nervous system.¹ Neurotechnology performs at least one of three functions: (1) **neuroimaging** (monitoring brain structure and function); (2) **neuromodulation** (influencing brain functions); and (3) direct **brain-computer interfaces**.²



WHY IT MATTERS?

Neurotechnology advances, particularly in the field of brain-computer interfaces, are poised to become a far more routine part of our lives, moving well beyond medical treatment. The widespread use of these technologies raises ethical, human rights, and security concerns.

Neurotechnology has played a crucial role in addressing some of our most widespread diseases and disorders for decades. Deep brain and nerve stimulation has helped to eliminate the symptoms of Parkinson's disease and epilepsy.³ Today, more than 600,000 people are able to hear due to cochlear implants stimulating their auditory nerves.⁴ Hundreds of thousands of people with spinal injuries and nerve disorders have been able to regain mobility and limb movement through brain-computer interfaces.⁵

WHAT ARE THE LATEST DEVELOPMENTS?

Recent breakthroughs are enabling brain-computer interfaces to transition from simple sensation and motor skills to higher-level cognition.⁶ Today, the technology is increasingly able to deliver collaborations between humans and AI, where the brain and the AI system respond and evolve together.

In early 2024, Neuralink successfully implanted an AI-powered device in a human patient, allowing him to control computer programs solely with his thoughts.⁷ The Chinese research team supporting Neuralink simultaneously announced advancement towards a fully wireless version that could enable less risky, more accessible applications of the same technology.⁸

In 2021, researchers at the California Institute of Technology unveiled an ultrasound technology that can "read" brain activity and anticipate mental responses. This non-invasive approach could revolutionize brain imaging, dramatically improving the diagnosis and treatment of neurological diseases like Alzheimer's and epilepsy. Beyond medical applications it may also enable the use of brain signals to control virtual or augmented reality.⁹

The development of finer, less intrusive tools is making the field far safer and more accessible. Recent advances include Synchron's "Stentrode," an electrode delivered via blood vessels that allows for implants without open brain surgery;¹⁰ Precision Neuroscience's "Flexible Electrode Array" which uses thousands of fine electrodes to capture brain activity;¹¹ and progress towards optical interfaces that could all but eliminate the need for surgical implants.¹²

Neurotechnology is not only becoming a more routine element of rehabilitation and treatment for people with brain

diseases and injuries, but also is rapidly expanding into non-medical uses. As more wireless, non-invasive technologies are developed, brain-computer interfaces may soon become part of everyday wearable technology, helping to monitor health, improve productivity in the workplace, or enhance virtual reality experiences.¹³ Eventually it could be incorporated into the daily decision-making of large numbers of people, potentially even linking individuals together to perform collective actions.¹⁴

WHAT ARE THE RISKS?

As neurotechnology becomes more routinely incorporated into humans, important ethical and practical implications arise, including:

- **PRIVACY, CONSENT AND HUMAN RIGHTS:** Neurotechnology collects highly sensitive neural data on individuals, which could become the target for hacking or unauthorized use. Questions of user privacy and informed consent are especially important, not least because the information could be used to manipulate a user's actions or thoughts.¹⁵ And in the case of widespread use, scenarios of surveillance states and authoritarian forms of governance are possible.¹⁶ The same concerns that exist for the inappropriate uses of private data from social media also apply to data generated by neurotechnology, but with potentially far more invasive outcomes. The field of "neuromarketing," which uses brain data to identify user preferences for commercial uses, is poised to become a widespread tool for companies.¹⁷ As a result, the potential for neurotechnology to result in large-scale human rights violations is an increasing concern.¹⁸

- **HUMAN AGENCY:** Some brain-computer interface users have reported a changed feeling of agency, including a perception that their actions are not their own.¹⁹ This points to potential longer-term legal and ethical questions about who is acting (imagine a scenario where a person pulls the trigger on a gun and claims it was their computer interface, not them). Where brain-computer interfaces are used to connect humans into group activities, questions of agency and accountability may become even more complex.

- **SECURITY:** There is a growing risk of an "augmentation arms race" as soldiers may soon become computer-enhanced to improve their sensory perceptions, reaction times, or endurance. "Cyborg soldiers" possessing super-human capacities and connected to unmanned drones or other

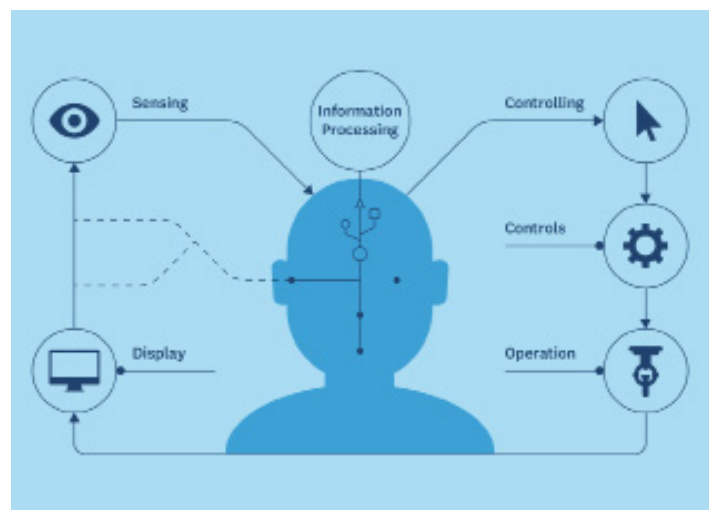


Diagram of a brain-computer interface

weapons systems are no longer only the realm of science fiction.²⁰ Augmented warfare may also present novel scenarios that are difficult to capture by existing understandings of international humanitarian law.²¹

- **INEQUALITY:** As of today, the capacities to develop and test neurotechnology exist almost exclusively in the Global North. This means that neurotech development and its social benefits will be concentrated in the developed world. In the longer term, this could lead to a division between "augmented" and "un-augmented" societies, with risks of deepening global inequalities.²²

WHAT ARE THE IMPLICATIONS?

As of today, the regulation of neurotechnology is almost exclusively managed by national governments or regional organizations.²⁶ Lack of internationally-agreed norms could drive some of the risks, particularly around an “augmentation arms race,” but could also allow for dangerous uses in many parts of the world. In this context, the UN has taken important steps, including UNESCO’s **Universal Declaration on Bioethics and Human Rights**, which provides

a normative framework for the safe, equitable development of neurotechnology.²⁷ The UN Human Rights Council has also taken up the possible human rights impacts of neurotechnology, creating an **Advisory Committee** and calling for a study.²⁸ While necessary, these steps are unlikely to be sufficient to the growing risks of neurotechnological development.

WHAT ARE THE CONSIDERATIONS?

• ETHICAL RESEARCH AND EQUITABLE DEVELOPMENT OF NEUROTECHNOLOGY.

The increasingly widespread impacts of neurotechnology may require more specific rules and/or regulation on research and development.²³ In particular, clear rules and protections around informed consent should govern questions of brain-computer interfaces.²⁴ Ensuring equitable access to the benefits of neurotechnology should also be a priority.

• **GLOBAL DATA PROTECTION STANDARDS.** Existing data protection frameworks in the EU and US already have some provisions that apply to neurotechnology.²⁵ However, as the usage becomes more widespread, it may be important to review global data protection norms and standards to align with the unique risks. A stocktaking of national, regional, and international standards and legislation, focusing on questions of efficacy and protections, could be a helpful next step.

• A FORUM FOR REGULATORS, PRIVATE SECTOR ACTORS, USERS, AND SCIENTISTS.

Developing viable guardrails for neurotechnology will require meaningful deliberations across these communities. Especially as the uses of

neurotechnology expand beyond the medical realm, bringing together the regulatory, commercial and scientific experts will be necessary.

• A BETTER UNDERSTANDING OF GLOBAL SECURITY RISKS.

The possible impacts of neurotechnology in the military domain are only beginning to be understood. Dedicated discussions on legal and practical questions of human augmentation could be held within major regional and international security governance bodies.

To ensure equitable access to neurotechnology advancements, the Global South requires support from the Global North through knowledge transfer, investment in research infrastructure, and capacity-building initiatives. Establishing regional research hubs, ethical governance frameworks, and talent development programs will foster innovation while addressing ethical and security challenges.

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